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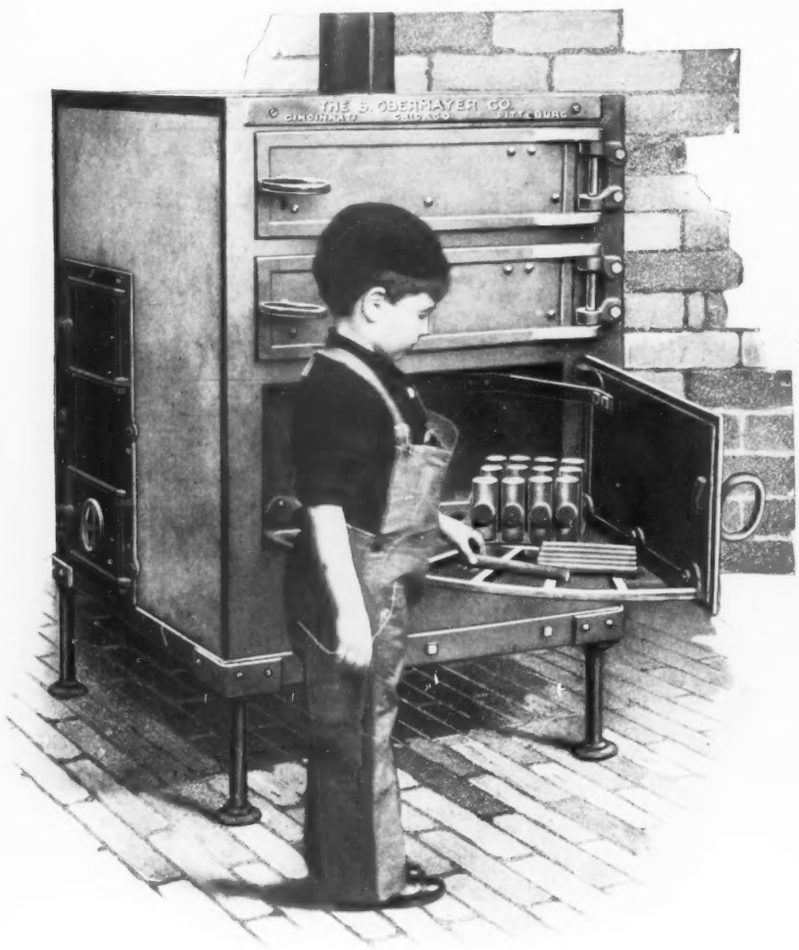

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THE FOUNDRY

Vol. 35, No. 1 CLEVELAND, OHIO, SEPTEMBER, 1909 Whole No. 205

BRITISH FOUNDRYMEN'S CONVENTION

Report of the proceedings of the sixth annual meeting of the British Foundrymen's Association held at Birmingham

BY J. HORTON

THE SIXTH annual convention of the British Foundrymen's Association was held in Birmingham, Eng., Aug. 3, 4 and 5, and, as usual, attracted a large attendance. The proceedings comprised the reading of a number of papers, and a varied program of visits of more than usual interest. A distinctive character was given to the event by a tour of the new university, recently opened by King Edward VII and Queen Alexandra, and the works visited were among the largest and most important in the kingdom. The meeting took place in the medical theater of the old university, a small and compact apartment, and a number of visitors were also present in addition to the members. The members paid their first visit to the Midland city under the most favorable conditions, the weather at the opening being charmingly fine.

The president, F. J. Cook, gave a hearty welcome to the members, and expressed the hope that the sixth convention would be as successful and helpful as its predecessors had been, and that the program would be generally acceptable. In connection with the balance sheet and report, Mr. Finch offered some criticism on the ground that the membership was not going forward as well as could be wished, and he suggested the appointment of a small committee to specially consider extension. The chairman stated that there had been a net gain for the year of 66, including 25 ordinary members. Mr. Carrick suggested that the best way to increase membership was to place likely members in touch with the secretary. The balance sheet was eventually adopted, and after some complimentary references to the work of Mr. Allbut, the secretary, it was decided to grant that officer an honorarium of £20 as a small recognition of his services. Percy Longmuir, in supporting this, said the association was becoming very influential, and was really making great progress.

F. J. COOK
President B.F.A.

The next business was the election of officers, which resulted as follows: F. J. Cook, president; Percy Longmuir, senior vice president; C. Jones, junior vice president; F. W. Finch, treasurer, and J. E. H. Allbut, secretary. Council: W. J. Morris, C. Heggie, L. Graham, W. F. Bagnall, W. J. Ellis and C. Morehead.

Mr. Allbut, in acknowledging his election, pointed out that the association was growing rapidly in numbers and influence, and the honorary members had increased considerably. The time was not far distant when they would need a secretary to give his whole time to the work. A number of very complimentary references were made to the work of Mr. Cook and Mr. Longmuir. Mr. Pilkington introduced a proposition emanating from the council fixing the annual subscription of members at £1-1 per year, associate members 10s-6d, associates 3s. Mr. Pilkington pointed out that the progress of the association demanded considerably more expenditure. They would have to print more literature, and provide more money for propaganda. While the Birmingham branch had been self-supporting, the Manchester and Sheffield branches had cost 2s-3d per head from the funds of the central body.

A somewhat lengthy discussion followed, in which

it was explained that in the future there would be no limit to the smallness of a new branch of the association, and money would be found for starting new branches with speakers supplied from the great centers. Some criticism was offered to the proposal to admit at a small payment of 3s, but a strong plea was made by Mr. Heggie on behalf of the workmen, whom they were very anxious to secure, and this feature was allowed to remain. Mr. Longmuir pointed out that the subscription of the American association was 2 guineas per year.

Official Welcome.

The proceedings were interrupted at this stage to receive the official welcome by the deputy lord mayor (Alderman H. J. Sayer). The president explained that the lord mayor was out of England or he would have attended, and they would then have been welcomed by a member of a large firm of iron founders of world-wide repute.

The deputy lord mayor said it was a great pleasure to welcome the organization to the city of Birmingham, especially as it is purely an educational society.

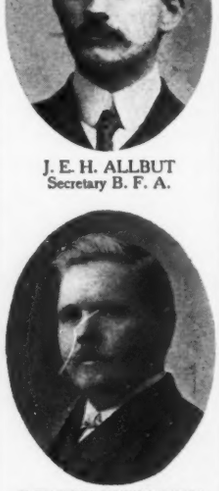
Consideration of the financial changes proposed was resumed, and after further discussion were unanimously adopted. Some interesting personal compliments followed. Robert Buchanan, on whose initiative the association was founded, proposed that A. H. Hiorns, head of the metallurgical department of the technical school, be invited to become an honorary life member of the association. He added that Mr. Hiorns was a very famous man in the metallurgical world, and had been a particularly good friend of the Birmingham branch, attending most regularly, and greatly assisting with papers and in contributions to the discussions. Mr. Longmuir seconded this, paying a warm tribute to Mr. Hiorns on behalf of outside districts. He had personally, through his works, been a student of Mr. Hiorns, long before he had the pleasure of meeting him. He had read his books, which were full of good matter, and of most practical information. The chairman supported this with much pleasure, declaring that the strength of the Birmingham branch was largely due to the veteran metallurgist. The resolution was carried.

Mr. Hiorns, in acknowledging, said the compliment had taken him by surprise. His attendance at the branch meetings had always been a great pleasure. He felt he had received a great deal more than he had given. He was very ready to acknowledge that experiments in the foundry, and experiments in the laboratory were very often quite different, because in the foundry, metal is dealt with in large quantities, which sometimes behaves very differently to what it does in small quantities.

PERCY LONGMUIR
Vice President B. F. A.

CHARLES JONES
Vice President B. F. A.

J. E. H. ALLBUT
Secretary B. F. A.



ROBERT BUCHANAN
Member of Council, B. F. A.

HERBERT PILKINGTON
Member of Council, B. F. A.

The chairman next called attention to a large, handsome, gilt-framed illuminated address to be presented to his predecessor in the chair, Herbert Pilkington, of Chesterfield. Mr. Pilkington is very well known in America, where he spent several years prior to taking his present position as general manager of the Sheepbridge Iron & Steel Co., Ltd., Chesterfield.

The address reads as follows:

"To Mr. Herbert Pilkington, M. I. C. E.—We, the members of the British Foundrymen's Association, desire to place on record our sincere thanks for the valuable services as president rendered to us during the two years ending August, 1908, and to mark our esteem and appreciation of the ability and initiative displayed by you in the conduct of the affairs of the association. We have much pleasure in asking your acceptance of this address, and earnestly hope that you may have every happiness and prosperity."

The president said the presentation of the address was a very pleasant duty, as Mr. Pilkington had done very useful work. Mr. Pilkington acknowledged the gift in a few felicitous sentences. On the proposition of Mr. Winterton, seconded by Mr. Markland, a hearty vote of thanks was accorded the officers for their services during the year. The former speaker expressed his great satisfaction at the possession of £103 in the bank to the credit of the association. The compliment was briefly acknowledged by the president.

On the proposition of Mr. Mather, seconded by Mr. Buchanan, it was decided to acknowledge in some tangible form the services rendered since the formation of the association by Mr. Finch, the treasurer.

Presidential Address.

The president then delivered the following address:

Six years ago the society was launched, purely as an educational body, and we may say without the slightest hesitation that the progress made has more than justified those who called the organization into existence. The results achieved in so short a time have exceeded the fondest expectations of its promoters. Much more, however, still remains to be accomplished in at least three directions. Our first object must be the educa-

tion of ourselves, and those associated with us in every department of foundry work. Something has also to be done in the education of those responsible, either directly or indirectly, for the design of the work which the foundry has to carry out. A third important requirement is the education of those who are placed under our care, the youthful students of foundry work upon whom will rest, in the future, the responsibility for maintaining the foundry trade of Great Britain where it undoubtedly stands at present, in the premier position of the world.

Education of Designers.

A word or two may be said with regard to the education of designers, whose duty it is to specify precisely the work required from the foundry, and who are responsible for the character and general lines of the machinery called for. Our universities and technical schools shou'd do much to supply the equipment of knowledge as well as to give encouragement to originality. Certainly the designer is as much in need of training as the foundryman. If the original design is inherently faulty, the best of workmanship will not produce a satisfactory result, and it is equally useless and unfair in such cases to blame the workman. In particular, something further is required in the training of the draughtsman. As a rule, the boy entering the drawing office is the boy who has done well at a public secondary school and desires an occupation rather above that of the ordinary workman. He goes at once into the drawing office to learn to draw, and seldom or never has any direct intercourse with the work shops, and is therefore ignorant of the ordinary routine work of the department of actual production. He may have been diligent in picking up knowledge at the technical school with regard to mechanics, mathematics, etc., but he knows nothing of metallurgy or the practical work of the foundry and the pattern shop, or, indeed, of metals generally. The result is that his designs are often merely fine specimens of misapp'ied ingenuity.

Success of American Designs.

A fact frequently commented upon is the general success of American designs. While trans-At'antic machines are pleasing to the eye and doubtless suitable and adequate for the work they have to perform, they are produced with a view to the lowest expenditure both in the pattern shop and the foundry, in respect to the time expended in molding, and the amount of material to be used. This result, I believe, is undoubtedly due to the large interest which American engineers generally take in the foundry and the allied departments, and the assistance which the engineer gets from the numerous technical col'eges which are such a feature of America.

R. W. KENYON
Member of Council, B. F. A.

W. J. ELLIS
Member of Council, B. F. A.

P. MUNNOCH
Member of Council, B. F. A.

W. H. SHERBURN
Member of Council, B. F. A.

SYDNEY C. SMITH
Author of "Rule of Thumb and Science in the Foundry"

Instruction in Practical Foundry Work.

In Great Britain we are just beginning to see the importance of practical, up-to-date teaching in regard to foundry and kindred subjects. We have one or two instances of universities and technical schools giving instruction on practical foundry matters, but unfortunately the methods so far adopted are far from being effective. One large educational center I have in mind is equipped with a foundry, but is not under the charge of a metallurgist, being controlled instead by the head of the engineering department, while a further defect is that the students are not necessarily included among those who take the metallurgical course. Apparently the sole function of this department appears to be to provide castings for the engineering students to work upon. Let it be understood that I do not depreciate the amount of education the student will get from the production of fine and small castings, but I fear that the student is likely to prove the truth of the adage about a "little knowledge being a dangerous thing," and when he emerges into practical life, he is quite likely to find that the knowledge he has acquired is of very little use to him. Real'y, the student only obtains about as much practical experience as he would get in a few weeks at an ordinary foundry.

Research Work.

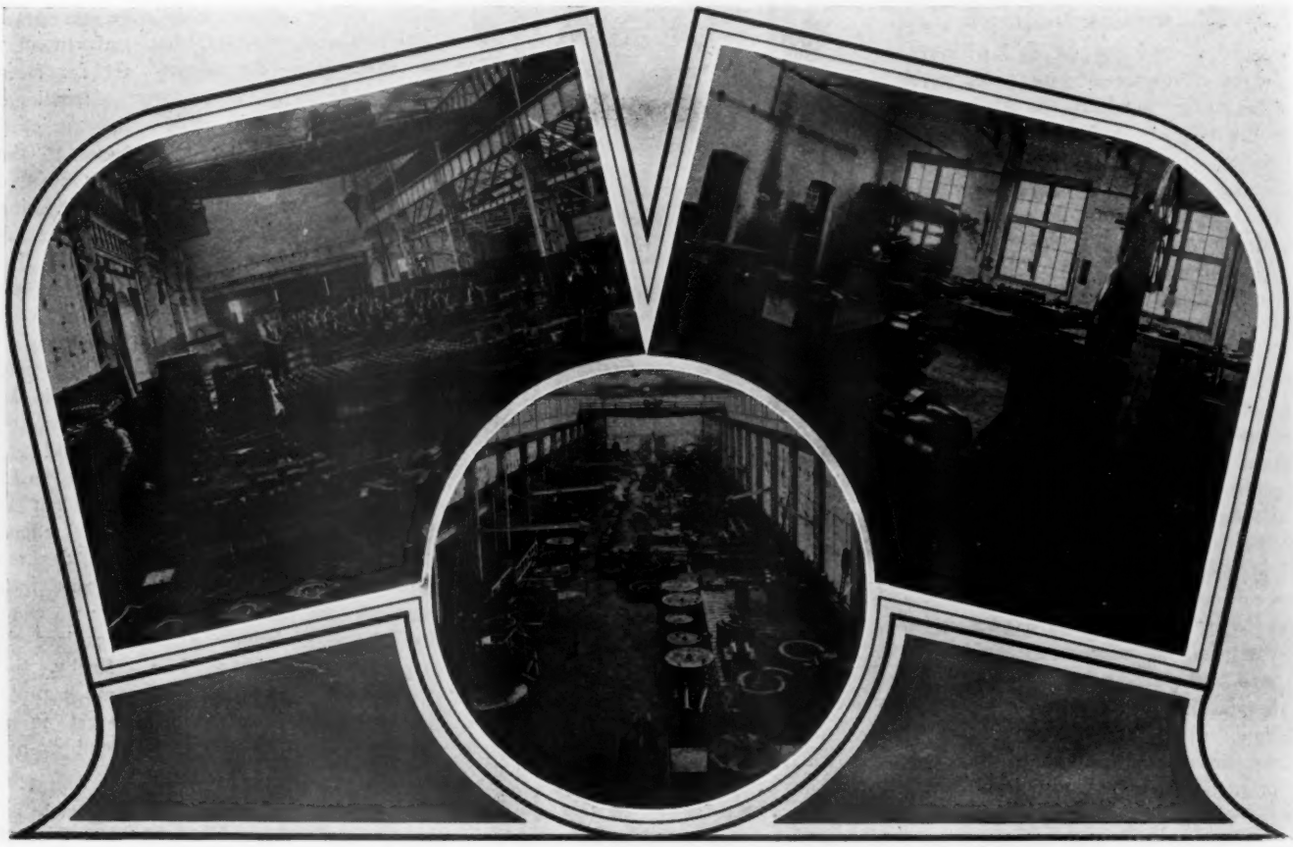
What I would like to see in such an establishment would include the consideration of problems of every-day importance for the purpose of thorough research work, and I would not mind if a student never made a mold, provided he watched operations with a lively interest in the solution of the problem. For example, an inquiry of the utmost importance, and one which wou'd be of valuable assistance in after life, would be a careful study as to the effect of design upon the structure of the metal of a casting. Such a course on simple lines could be easily arranged, and its effect would be to implant in the mind of the student clearly defined ideas as to the design to avoid, and also the lines upon which he

should go in order to insure successful results. It is not to be expected, of course, that the teachers and professors in charge of these establishments can be up-to-date in practical foundry work, but there is no reason why in large and important engineering centers, having ample facilities for this class of work, a committee should not be formed, consisting jointly of teachers and practical foundrymen, who could combine their energies in the framing, from time to time, of a syllabus of work likely to be of practical use.

The training of the juniors placed and especially for boys leaving school at thirteen. There might during the last year be some form of compulsory attendance at a technical school on one or two afternoons in the week, where he could be taught something directly applicable to the scientific side of the trade he is selecting, which, in this case, would be the foundry. The results would be better, while the system would cost no more than at present.

It should be our care, in the interests both of the trade and the students of practical foundry work, to see that apprentices make the most of that department of engineering production to which we belong, and of which we are justly proud.

On the proposition of Percy Longmuir, hearty thanks were accorded the president for his address. In seconding this, Prof. Turner said the address was extremely suggestive and thoughtful. He added that the speaker showed considerable sympathy with the young people, and if those ideas could be put into practice it would be very beneficial to the trade. The president, acknowledging, said he felt very strongly on the educational question, seeing that they



FOUNDRY, MACHINE AND PATTERN SHOPS OF THE BRITISH THOMSON-HOUSTON CO., BIRMINGHAM, VISITED BY THE MEMBERS OF THE BRITISH FOUNDRYMEN'S ASSOCIATION

under our care constitutes another most important responsibility deserving of careful consideration. Our foundries are recruited largely from the ranks of the average school boy. With regard to this class there is no higher or secondary education, and one of the defects of the ordinary school is the lack of interest on the part of the boys in the somewhat abstruse subjects taught during the last two years. It is a question worth considering whether the concluding period of his schooling, could not, to some extent, be utilized as special preparation for his own line of work, of the period of youthful training passed in our workshops. The special vocation of the Foundrymen's Association is to produce that alertness of mind and that spirit of continuous investigation which enables the aspiring foundryman to make continual progress. I believe that the average British molder is second to none in the world; but if we are to maintain the premier position we shall have to produce a class of still abler workmen, and strict attention must be paid to the broad, general education of those whose business it will be to initiate control, and carry out the work were a long way behind in such matters, in this country.

Twenty-Five Years of Cast Iron.

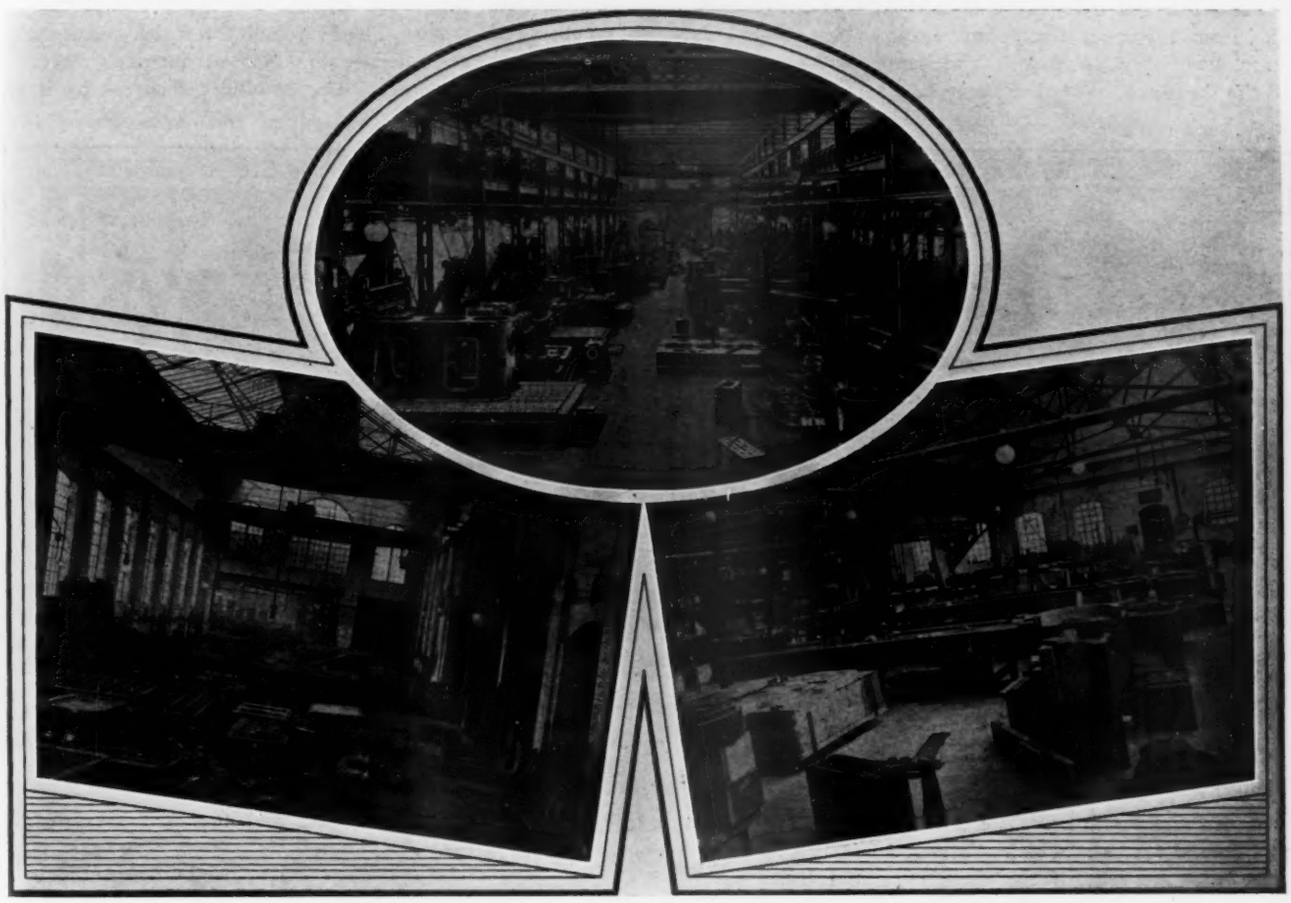
Prof. Turner next read his paper on "Twenty-five Years of Cast Iron," which was very well received. A. H. Hiorns, in opening the discussion, said that the classical experiments of years ago had led to very important results. Prof. Turner might claim to have been the first to bring before the notice of iron founders the very important effect of silicon on cast iron. His results were obtained with very limited apparatus. There was no

microscope nor pyrometer to speak of in those days, and it had been to himself a matter of surprise that Prof. Turner had been able to do so much with so little apparatus. With regard to silicon it was only under certain conditions that the results occured which Prof. Turner brought out. Under other conditions, silicon acted in opposite directions.

Herbert Pilkington said that the historical sketch was almost a textbook of information, and should prove very valuable to members. Referring to some remarks by Prof. Turner to the effect that while chemical composition was of great importance, analysis was only one aid to the iron founder, the speaker said no doubt Prof. Turner would recollect that 22 years ago when he (the speaker) made a similar observation at a meeting of the South Staffordshire Institute, the reception by the chemists was not kindly.

Mr. Longmuir said most chemists recognized that analysis was not the pure-all for every trouble, but foundrymen must take advantage of every aid offered by science, though they would not find solutions of every problem. Personally, he had been intensely interested in the experiments of Prof. Turner, who was the first to lay the foundation of scientific foundry practice. In all essentials, the declared results of 25 years ago were true today, and that could not be said of many researches. They are capable of application in any ordinary foundry work and experience since gained has confirmed the original conclusions. Many years ago, when a raw student, he had to go rather deeply into the control of cupola mixtures.

Mr. Smith, Chesterfield, asked the meaning of the term "washed iron." Replying to Mr. Smith, Prof. Turner said that "washed iron" is a commercial product which could be bought. It is as nearly as possible a pure iron containing 3 per cent carbon in the combined form.



FOUNDRY, MACHINE AND PATTERN SHOPS OF BELLISS & MORCOM, LTD., BIRMINGHAM, VISITED BY THE MEMBERS OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Production of Patterns for Light Castings.

W. H. Sherburn, Warrington, followed with a paper entitled "The Production of Patterns for Light Castings." Mr. Cook said that there was no doubt a necessity for a closer relationship between the foundryman and the patternmaker, although the necessity was not quite so great in regard to light castings as in engineering. As a rule, the patternmaker knows something about molding, and he is able to eliminate some of the difficulties.

Mr. Noon inquired whether Mr. Sherburn, in running plaster patterns, used any other material for his mixture. Mr. Sherburn, replying, said usually he did not. It was not necessary, because if the plaster of Paris sets too rapidly, a small amount of lime could be added. C. Heggie remarked that the patternmaker was in a difficult position because he frequently had to make up for the designer's lack of knowledge. He said he would like to hear something further on the question of twisting and bending of patterns. In some cases they had to allow ⅛ to ½ inch over the pattern, to get a proper casting, and sometimes they had to give a certain amount of camber to alter the runner. Mr. Sherburn said it had always been a question among patternmakers as to the proper course to pursue, whether to

bend the patterns so as to counteract the natural tendency, or to add or take away weight to bring the casting right. He added that iron follows no erratic law and that there is a reason for all the twists and bends which occur. It is therefore necessary to modify according to circumstances.

University of Birmingham.

About 70 members accepted the invitation of Prof. Turner, head of the metallurgical department of the University, to visit that fine institution at Bournbrook, Tuesday afternoon.

The University of Birmingham had its beginning in Mason Science College, founded by Sir Josiah Mason, who from a comparatively humble position had risen to wealth and fame as the head of one of Birmingham's great pen-making firms. The building in Edmund street, which until recently was the seat of the university, was opened in 1880. Mason's views as to the need of a systematic and scientific education in a manufacturing community were a little ahead of those of his contemporary fellow-countrymen. He laid it down that science teaching was to be the first consideration, but beyond stipulating that no religious creed or dogma should ever be taught in the college, he left the trustees full liberty with regard to future developments.

It is to the Rt. Hon. Joseph Chamberlain that the successful launching of the university in its present form is to be credited. He raised the fund which justified an application for a royal charter. An examination of the English educational institutions failed to furnish the advisory committee with what they considered an adequate basis for the scheme of the university. The council, therefore, readily accepted the advice given by Andrew Carnegie with his donation of £50,000, to make itself well informed of what was taking place in America.

New Buildings.

The new buildings at Bournbrook form the headquarters of the university, while the teaching departments provided are mainly those concerned with scientific and technical subjects. The original building of Mason college, in Edmund street, in which the convention meetings were held, will be retained for the faculties of arts and medicine, the day-training colleges, the school of brewing, etc. The new buildings are about three miles away, on a site of 34 acres, presented to the university by Lord Calthorpe.

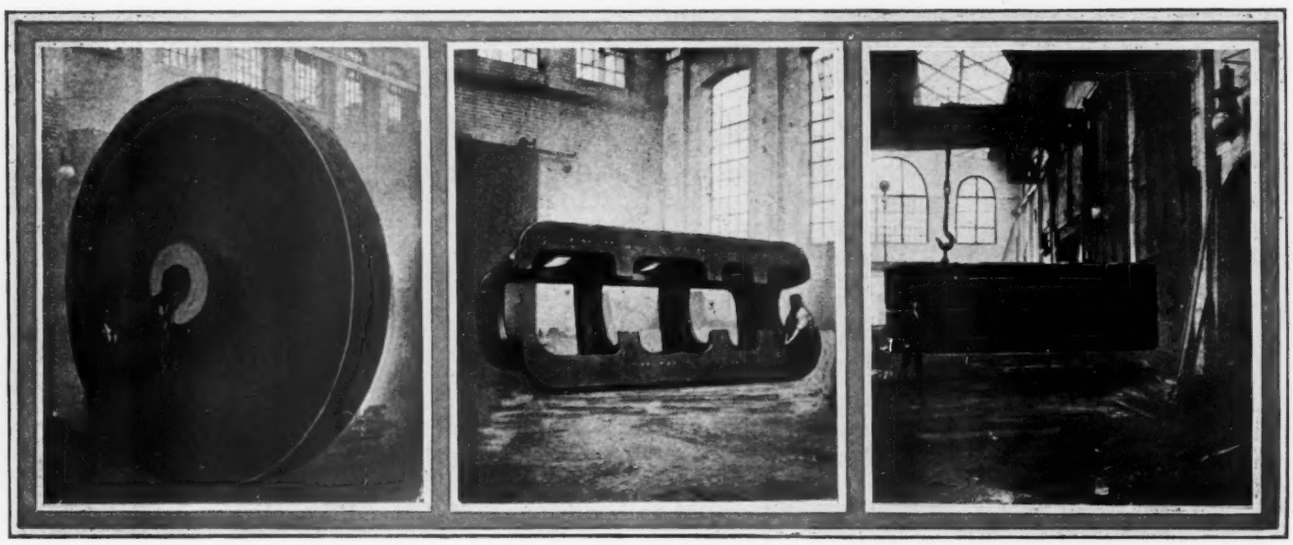
The plan of the principal block of the new university buildings is a series of radiating arms stretching out from a semi-circular front. In this front are contained the secretary's offices and other administrative buildings, while in the T-shaped arms are the laboratories, work shops, and drawing offices. Each arm is 100 feet long and 50 feet wide, the T being completed in each case by a transept measuring 90 feet by 45 feet. Of these radiating arms there will be ultimately eight, in addition to the Great Hall, which forms the middle radial and is somewhat different on plan from the others. Of these radial buildings, only the Great Hall and four others have as yet been completed. In these have been installed the departments for mining and metallurgy, civil and electrical engineering, mechanical engineering, chemistry and physics. Some 200 yards from the main building is the power station, which furnishes electricity, steam, heat, and gas for various purposes to the whole establishment. Near the power station are the foundries, forges, and other experimental plant of the metallurgical department. Under a large portion of the ground runs an experimental mine for practical instruction in mining operations. The total cost of the buildings and equipment is about £500,000.

Metallurgical Department.

To the foundrymen the metallurgical department proved intensely interesting. The buildings occupied by it are the largest and the best arranged in the United Kingdom. In the main building about 20,000 square feet of floor space is devoted to metallurgy. One of the large shops is exclusively for steel making, the other for treating ores of non-ferrous metals. For the steel melting there is a two-ton, new form of the Siemens regenerative furnace, with the necessary gas producer, electric hoist, crane, boiler, and casting pit, the furnace being also arranged for experimental work with gas from the power station. One of the small shops will be devoted to electrical smelting, and the other contains a small experimental steel and brass foundry for pit furnace work.

Tuesday Evening.

The afternoons of the foundrymen being fully occupied, the visit to the



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BED FOR A 3,000-HORSEPOWER ENGINE MADE BY BELLIS & MORCOM, LTD.

LARGE 30-TON CORE MADE IN ONE PIECE FOR ENGINE BED CASTING

Municipal Tramway generating station, Summer Lane, Birmingham, was necessarily allotted to Tuesday evening. The electrical department is rapidly forging ahead to a position of distinction among the city's great money-making undertakings. It has grown very rapidly, having been purchased from a private company in 1900. It became immensely important when three years later the corporation municipalized the tramways and began running them with overhead electric traction. This development necessitated the acquisition of four and one-half acres of land for the Summer Lane generating station within a few hundred yards of the center of the city.

Wednesday Morning.

The proceedings were continued in the medical theater of the old University on Wednesday morning. The business was restricted to the reading and discussion of the three remaining papers: "Influence of Chemical Compounds on the Properties of Cast Iron," by A. H. Hiorns; "The Application of Rule-of-Thumb and Science in the Foundry," by Sidney G. Smith, and "Introduction to the Effect of Structure Upon the Physical Properties of Cast Iron," by F. J. Cook and G. Hailstone.

Criticising a statement that phosphorus lessened the shrinkage of cast iron, Prof. Turner said that as long as the phosphide of iron remains in solution, it appears to have very little effect on the shrinkage, but when the phosphide separates in the form of phosphide eutectic, there is a reduction in the shrinkage. In gray iron, where the phosphide separates out, it produces an effect on the chill.

R. Buchanan dealt at some length with the question of blow holes, controverting Mr. Hiorn's statement that a high temperature facilitated the formation of these defects. Foundrymen agree that castings poured from hot iron are more solid than those cast at a dull heat. He added that certain kinds of blow holes, especially pin holes, were caused by sulphur, and if sulphur is present it is a matter of indifference whether the iron is dull or hot. The speaker deprecated any conclusions from Brunell's experiment because he dealt with steel, which was almost a totally dissimilar metal. The putting of a head plate on the top of an ingot tended to enclose the gases and so keep them in solution.

H. Pilkington said he was very glad to hear that the foundrymen did not blame the maker of pig iron for blow holes, but that was not his own experience. There was another form of blow hole due to imperfectly dried cores. If metal for pipe castings is poured at a very high temperature better results are obtained than if the metal is dull. With regard to manganese, he said that it assisted chill, but it was a different chill to that of carbon and the alloy should be carefully used.

Mr. Hiorns, in reply, said it was news to him that there was any difference between pin holes and blow holes. He defined blow holes as any holes produced by the action of gases. No doubt it was different with large quantities, but in a crucible the effect of making metal too hot was to intensify the number of blow holes. If it were possible to keep the top of a casting open so that all the gases could escape there would be no blow holes, but these were caused by the enclosure of the gases in a solid envelope so that they could not escape. He stated that steel is cast at a very high temperature which assists in the absorption of gases and that little difficulty is experienced with metals, such as lead, which have a low melting point. With copper, blow holes are a source of constant trouble.

Rule-of-Thumb and Science in the Foundry.

The president opened the discussion of Mr. Smith's paper. With regard to blast pressure, he said that if Mr. Smith would start with 10 ounces pressure and put it up to 16 ounces he would get his metal harder for a short time, because the cupola would have a cooler hearth. However, when the furnace recovered, the temperature would increase and therefore softer iron would be secured. He had always contended that the class of iron required for hard castings was obtained at the end of the day's blow, and the usual practice was to empty the cupola and make up the bed with special iron.

Mr. Pilkington, after complimenting the writer, said he was sometimes called in to arbitrate between the draughtsman and the foundryman. He found that the difficulty in the training of draughtsmen was that the youths would go through the pattern shop and the machine shop, but they either refused to go into the foundry, or would not stay there long. With regard to rule-of-thumb, he had often wondered at the wonderful work done by the old makers of cold blast iron and chilled rolls who accomplished these results solely by selecting iron by fracture. The speaker gave instances of different results arising from the use of irons of a similar analysis. With regard to blast pressure he preferred a large amount of tuyere area and a very low pressure.

Mr. Carrick believed there had been too much effort at excessive charging of cupolas, which had been the cause of a great deal of trouble.

R. Buchanan complimented the writer on having produced a most sensible paper and added that it was refreshing to find a foundryman speak in behalf of the rule-of-thumb man. He admitted that it was quite true that the foundry rule-of-thumb practice was necessarily scientific; but the function of the association was to make the practical man recognize the laws under which he was working, and so induce him to use those laws to his own end, while making him understand also that if he transgressed the scientific laws he must suffer.

Mr. Mason thought the thanks of the association were due the firms who had allowed practical men to give papers. In at least two cases, in Birmingham, members willing to give papers had been prohibited by their employers. He disagreed with the suggestion that 28 pounds of limestone was sufficient to flux a ton of iron. At his establishment they required 40 to 44 pounds. With regard to the use of the term "alumina," he said that it would be more intelligible if they would use the word clay.

Effect of Structure on Physical Properties of Cast Iron.

The joint paper by F. J. Cook and G. Hailstone was next read, illustrations being thrown on the screen, showing various tables of analysis and micro-structures.

Percy Longmuir said the authors had clearly shown that a certain type of structure had distinct mechanical properties. The speaker introduced a number of tables and slides from a paper read some years ago before the Glasgow and West of Scotland Institute, showing the various graphitic changes which were associated with a considerable gain in tensile strength. He held, that if a method could be devised of introducing fine graphite, they could regularly secure a tensile strength of 18 tons per square inch. The increase of density involves the loss of other properties, and low tensile bars would probably give better resistance to shock. The high carbons were apt to be brittle, and to break off when tapped with a hammer, while the low carbons,

without the net-like structure, would bend double and might be smashed together without showing fracture. While offering these suggestions, he was satisfied that further investigation in the same direction would greatly benefit the iron founder.

Prof. Turner said the paper opened up a wide field of investigation. It was clear there was a rate of cooling which would give high physical properties, and it seemed that the best physical properties were associated with the small graphite which had been recognized for a long time. No doubt Mr. Longmuir was right as to the importance of the cell walls. If the walls were sufficiently thick the metal would be brittle. The different results secured, where the material and treatment seemed to be almost the same, was due to the fact that the metal was of such a composition that the proportion of sulphur was extremely important, and a slight change made an enormous difference. Sulphur would cause the graphite to become smaller. By changing the size of the graphite a stronger iron is produced. Changes in structure might be produced by modifications in the rate of cooling.

Herbert Pilkington said he was glad they had come to the conclusion that with an ordinary commercial pig iron, no matter what the chemical composition, there was a rate of cooling which would give high physical properties. Mr. Cook had conceded the point that there was something in grading after all. The speaker found fault with the matter of testing, and said the only proper test for cast iron was a machine tensile test. Personally, he had been experimenting in trying to produce cast iron of great tensile strength by hastening the time of cooling artificially, but he would not publish the results of unfinished experiments.

Mr. Swindon, Sheffield, related some interesting experiences in Sweden, where splendid iron was produced. A typical analysis follows: combined carbon, 0.2 per cent; graphitic carbon, 2.4 per cent; silicon, 2.8 per cent; manganese, 0.6 per cent; phosphorus, 0.05 per cent, and sulphur, 0.15 per cent. That yielded a tensile test of 19.2 tons, and a transverse test of 3,800 to 4,600 pounds. The daily output is only about 16 tons, compared with 100 tons in British furnaces. He thought the small output had much to do with the quality, and when they tried to increase the output in Sweden, although they used the same material, they lowered the quality.

Mr. Cook, replying, said that the essential feature which seemed to determine the strength was the net-like structure in the stronger iron. Personally, he did not think the sulphur had anything to do with it. He had known many instances where the rushing of a furnace had lowered the quality. This concluded the discussion.

The proceedings ended with an "omnibus" resolution of thanks to the governors of the university, to Prof. Turner, the readers of papers and the local committee for their share in promoting the success of the gathering.

Wednesday Afternoon.

On Wednesday afternoon the members paid a visit to the Icknield Square works of Belliss & Morcom, Ltd., Birmingham. This firm was founded over half a century ago by the late G. E. Belliss. In its earlier years the firm specialized in the manufacture of machinery and boilers for high speed naval vessels, such as torpedo boats, gunboats and destroyers, and many vessels of this class were equipped from their Ledsam street works. In this class of work, minimum weight per horsepower is of great importance, the type of engines being required to run at very high speeds.

The works at Ledsam street are employed in the manufacture of auxiliary machinery and the smaller sizes of engines, while the larger engines for use in factories and electric power stations, which form the greater part of the firm's output, are constructed at the works in Icknield Square. This plant is complete in itself, comprising generating station, foundry, smithy, machine, erecting and testing departments. Generally, the shops are capacious, well-lighted and heated, and kept in a most orderly manner. Electric driving is employed throughout, and the shops have been arranged to insure the minimum amount of handling of the work during manufacture.

The Foundry.

The foundry is a lofty, well-lighted brick building, 390 feet long, the molding floor space for 230 feet is 50 feet wide, and the remainder 40 feet wide. The adjuncts consist of general stores, coke stores, cupola houses, coremakers' shops, sand mixer space, and fettling shop.

The cupola practice is scientifically up-to-date, all raw materials are regularly analyzed, besides which a comprehensive series of mechanical tests are taken every day. By close study of the results obtained, this concern is able to produce castings having a very high degree of strength. During the last 100 consecutive days working, the records of tests have been: highest tensile test, 41,440 pounds per square inch, the average of the whole series being 35,840 pounds per square inch. The output of the foundry is 100 tons per week, and examples of some of the large work are shown in the accompanying illustration. The one view shows a wheel weighing 25 tons, which is used on the 3,000-horsepower engine made by this firm. The bed for an engine of this size is also illustrated. The core for this frame, which is believed to be the largest core on record, being made in one piece and weighing over 30 tons, is also shown.

Pattern Shop.

The pattern shop is on the top floor of a three-story building, the remainder being used as a store for the small standard patterns. The shop is equipped with a full complement of up-to-date machinery. Special attention has been given to the lighting, and by means of a saw-tooth roof, amply glazed, a beautifully diffused light is obtained, without either shadows or the trying effects of the sun in summer. The pattern store has been well arranged and is remarkable for the absence of portable ladders for reaching the top part of the racks. This is accomplished by run-ways about six feet from the floor being fixed between the racks on which travels a platform; access to this is obtained by a fixed ladder at the end of each bin. The platform is large enough to carry a quantity of patterns, and is so arranged that the full scope of the bin on either side is within reach.

Machine Shop.

The machine shop is divided into three bays, 25, 50 and 25 feet by 280 feet. Over the two side bays are galleries, the one used for small machine work, the other being utilized for cylinder fitting. The machines installed are practically all of British make and comprise the latest and best examples of the tool maker's art.

The tool room, which is an important adjunct to an up-to-date machine shop, is situated at one end and is equipped with a complete range of jigs, gages and measuring instruments. As complete interchangeability of the finished parts of their engines is the aim of the company, unique gaging and jig devices are everywhere in evidence.

The erecting shop is divided into two bays, each 50 by 300 feet. It is

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication.

Note--This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

STANDARD SPECIFICATIONS FOR BUYING FOUNDRY PIG IRON.*

Percentages and Variations.

In order that there may be uniformity in grading, the following percentages and variations shall be used:†

Silicon. Per cent.	Code.	Sulphur. Per cent.	Code.
1.00	La	0.04	Sa
1.50	Le	0.05	Se
2.00	Li	0.06	Si
2.50	Lo	0.07	So
3.00	Lu	0.08	Su
3.50	Ly	0.09	Sy
		0.10	Sh
(0.25 allowed either way.)		(Maximum.)	

Total Carbon. Per cent.	Code.	Manganese. Per cent.	Code.	Phosphorus. Per cent.	Code.
3.00	Ca	0.20	Ma	0.20	Pa
3.20	Ce	0.40	Me	0.40	Pe
3.40	Ci	0.60	Mi	0.60	Pi
3.60	Co	0.80	Mo	0.80	Po
3.80	Cu	1.00	Mu	1.00	Pu
		1.25	My	1.25	Py
		1.50	Mh	1.50	Ph
(Minimum.)		(0.20 allowed either way.)		(0.15 allowed either way.)	

Illustration of the use of above coding: The word Li-se-ca-mo-pi indicates:

Sil.	Sul.	Carb.	Mang.	Phos.
2.00	0.05	3.00	0.80	0.60

with variations as allowed.

Percentages of any element specified half way between the above shall be designated by the addition of the letter X to the next lower symbol.

Example.—PeX indicates Phosphorus 0.50, with "allowed" variations (0.15) up and down.

In the case of phosphorus and manganese, the percentages may be used as maximum or minimum figures, but unless so specified they will be considered to include the variations above given.

Sampling and Analysis.

Each car load, or its equivalent, shall be considered as a unit in sampling.

One sample shall be taken to every four tons in the car, and shall be so chosen from different parts of the car as to represent as nearly as possible the average quality of the iron.

Drillings shall be taken so as to fairly represent the composition of the pig as cast.

*Adopted by the American Foundrymen's Association and the American Society for Testing Materials.

†These specifications do not advise that all five elements be specified in all contracts for pig iron, but do recommend that when these elements are specified, the given percentages shall be used.

(These specifications replace "Standard Specifications for Foundry Pig Iron" published in Data Sheet No. 1, THE FOUNDRY, September, 1907.)

Standard Specifications for Buying Foundry Pig Iron.

(Continued from Data Sheet No. 49.)

An equal weight of the drillings from each pig shall be thoroughly mixed to make up the sample for analysis.

In case of dispute, the sampling and analysis shall be made by an independent chemist, mutually agreed upon, if practicable at the time the contract is made.

It is recommended that the standard methods of the American Foundrymen's Association be used for analysis. Gravimetric methods shall be used for the analysis of sulphur, unless otherwise specified in the contract.

The cost of re-sampling and re-analysis shall be borne by the party in error.

Base or Quoting Price.

For market quotations, an iron of 2.00 per cent in silicon (with variations of 0.25 either way) and 0.05 per cent in sulphur (maximum) shall be taken as the base.

Clauses for Adjusting Disputes Between Buyer and Seller.

Base Table.—The following table may be filled out, and may become a part of the contract. "B," or Base, represents the price agreed upon for a pig iron running 2.00 per cent in silicon (with allowed variation of 0.25 either way) and under 0.05 per cent in sulphur; "C" is a constant differential to be determined at the time the contract is made.

This table is for settling any differences which may arise in filling a contract, as explained under penalties and allowances, and may be used to regulate the price of a grade of pig iron which the purchaser desires, and the seller agrees to substitute for the one originally specified.

Silicon percentages allow 0.25 variation either way. Sulphur percentages are maximum.

Sulphur, per cent.	Silicon, per cent. 3.25	3.00	2.75	2.50	2.25	2.00	1.75	1.50	1.25	1.00
0.04.....	B+6C	B+5C	B+4C	B+3C	B+2C	B+1C	B	B—1C	B—2C	B—3C
0.05.....	B+5C	B+4C	B+3C	B+2C	B+1C	B	B—1C	B—2C	B—3C	B—4C
0.06.....	B+4C	B+3C	B+2C	B+1C	B	B—1C	B—2C	B—3C	B—4C	B—5C
0.07.....	B+3C	B+2C	B+1C	B	B—1C	B—2C	B—3C	B—4C	B—5C	B—6C
0.08.....	B+2C	B+1C	B	B—1C	B—2C	B—3C	B—4C	B—5C	B—6C	B—7C
0.09.....	B+1C	B	B—1C	B—2C	B—3C	B—4C	B—5C	B—6C	B—7C	B—8C
0.10.....	B	B—1C	B—2C	B—3C	B—4C	B—5C	B—6C	B—7C	B—8C	B—9C

Penalties.—In case the iron, when delivered, does not conform to the specifications, the buyer shall have the option of either refusing the iron, or accepting it on the basis shown in the above table, which must be filled out at the time the contract is made.

Allowances.—In case the furnace cannot, for any good reason, deliver the iron as specified at the time delivery is due, the purchaser may at his option accept any other analysis which the furnace can deliver, the price to be determined by the base table above, which must be filled out at the time the contract is made.

equipped with six electric traveling cranes, and engines up to 1,200 horsepower can be lifted and carried about complete. In this shop, engines from 100 to 3,000 horsepower, are built. At one end is situated the test house. This is claimed to be the finest and best equipped testing department for commercial purposes in the world. It is divided into 11 berths and engines up to 1,250 horsepower can be tested under all working conditions, condensing or non-condensing, with steam pressures ranging from 80 to 250 pounds per square inch, and superheat up to 350 degrees Fahr. above saturation point. The electrical testing equipment can deal with voltages of 60 to 6,000, with currents from 10 to 2,000 amperes, either in direct current or in single or polyphase alternating current of various frequencies. Each engine is usually run at full load, light load, and varying loads. Regulation tests of the dynamo and governing tests of the engine are also generally made. A careful record of everything connected with the efficiency and running of the engines under these tests forms a valuable fund of information for the designing department.

The output of the works is roughly 150,000 horsepower per annum, this huge turnover being distributed among central station, collieries, iron works and railways at home, in the colonies and on the continent.

Thursday Morning.

Thursday morning was devoted to a visit to Rugby, about 30 miles from Birmingham, and a tour of the great engineering establishment of the British Thomson-Houston Co., Ltd. Probably Great Britain can furnish no better example of a thoroughly modern and up-to-date establishment, and its rapid, yet solid growth, is convincing evidence of the vitality of British engineering. The works were only established nine years ago at the important railway center of Rugby, and the extent of the works' site is 25 acres.

The colossal size of the plant is well suggested by the view of the machine shop, the length of which is 421 feet and its width 265 feet; but in addition to this there are foundries, pattern and woodworking shops, tool rooms, press shops, power houses, to the total number of 17, and a very large and well appointed office, with laboratories conveniently situated. The employes number nearly 2,000, of whom 140 are engaged in the foundries alone. The pattern shop employs about 50 men, and is 200 by 50 feet. The storage of patterns, where the variety is enormous, is a gigantic task, but everything is so perfectly classified that patterns can be quickly obtained. A narrow-gage railway communicates directly between the pattern shop and the foundries, which economizes both time and labor.

Iron Foundry.

The iron foundry is a fairly spacious building, 275 feet in length by 90 feet in width, a small section being devoted to brass and kindred alloys. The metals dealt with are aluminum, various brass alloys, phosphor bronze, and a variety of special metals peculiar to the firm. A great deal of the molding is done by machinery, partly by Tabor machines, and a couple of small machines of French make.

In the iron molding shops an enormous variety of work is produced. The traveling crane equipment consists of one of 10 tons and one of 30 tons capacity. Small electric jib cranes running near the wall are installed for handling medium-sized castings up to five tons. The department for making cores is fairly complete.

Machine Shop.

The most striking building of all is the great machine shop. The castings machined are necessarily of large size. For example, the boring mills are capable of handling work up to 24 feet in diameter. The drilling and planing machines are of great power and in this department everything is finished from the smallest article to the casing of the largest turbine. The bucket cutting machinery was a special feature, the buckets being cut out of solid metal. There is a large test bed for dealing with turbines, and several orders were in course of execution for horizontal and vertical turbines up to 3,000 kilowatts each.

A special feature of the shop arrangement is that, as far as possible, an article is started, completed and made ready for testing in one bay. By this means the work travels through without going a second time over the same ground.

A Run Through Leafy Warwickshire.

The remainder of the day was given up chiefly to enjoyment of the beauties of Warwickshire. The county is known to English people as the heart of England, and as "Leafy Warwickshire." To England and to all the world, and not least to Americans, it is a place of pilgrimage as "Shakespeare's Country."

The tour commenced at Rugby. After the visit to the Thomson-Houston works there, the party went by train to Leamington, one of the largest and best known of English inland watering places.

From Leamington the foundrymen drove to Warwick, passing on the way the quaint old birthplace of the poet, Walter Savage Landor. Warwick castle is a great shrine for Americans who love these survivals of medieval England. It is one of the finest of baronial feudal castles, and is still in excellent condition, while as being occupied by the family bearing the original title, it is unique.

The journey from Kenilworth to Coventry was taken along what has been described as the most beautiful road in England. Coventry has its share of interesting and historic buildings, but of late its fame has been chiefly commercial, as for many years the home of the silk trade, and, when this declined, the center of the bicycle industry. The latest addition is a huge factory for the manufacture of naval ordnance, and Coventry is now a very important center of the motor manufacture. As the foundrymen entered the train for Birmingham, they agreed that they had had a full and most interesting day.

BURNING OUT THE CUPOLA LINING.

By W. J. Keep

Question:—Our cupola is lined to 50 inches and our heats average 10 to 15 tons daily. We are melting at the rate of 7½ to 1. Our charges average about one ton each and the blast pressure is 12 ounces. We daub with fire clay but the bricks of the lining burn out very rapidly around the melting zone. We have used four different makes of bricks without better results, and reducing the blast to seven ounces did not overcome the difficulty. Our iron seems to carry an unusual large amount of slag and we are obliged to replace a number of bricks after each heat and to reline the melting zone completely every week.

Answer:—All of your operating conditions are good. The large amount of your slag undoubtedly results from the melted brick and the fire clay daubing, and might suggest that you change the grade of coke you are using. Clean machinery scrap might be recommended in the place of rusty stove plate. Do not charge the dirt which accumulates on the charging floor and charge evenly so as not to leave any open spaces. Break all of the scrap as small as the pig or as nearly so as possible. Use about 20 pounds of clear white limestone per ton of iron.

ENAMELED CAST IRON SANITARY WARE-IV

Construction of the cope and drag bath tub molding machines---The cope, cheek and drag flasks

BY DILLEN UNDERHILL

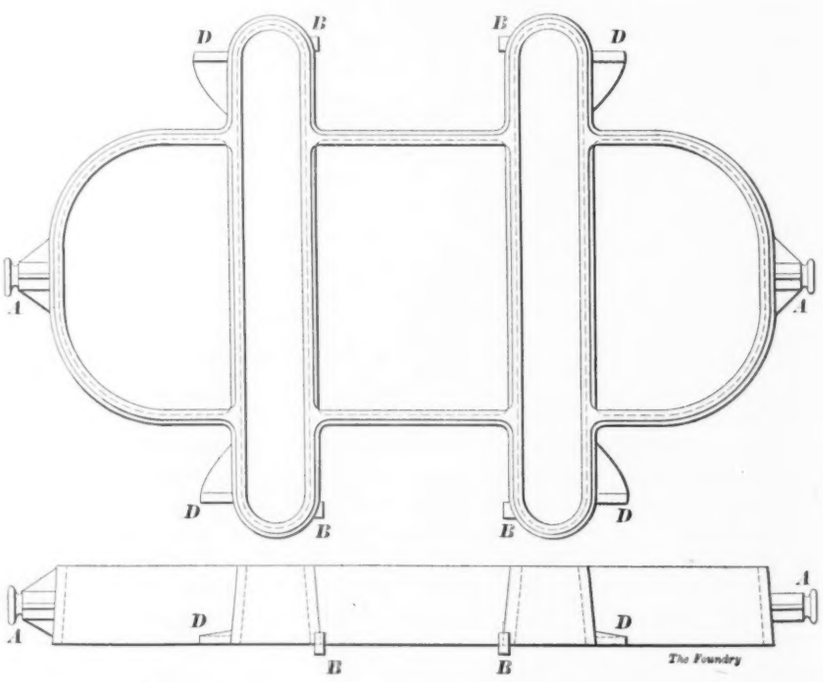
THE method of making the bath tub pattern for the cope and drag machines was considered in the last article, and we will now proceed with a description of the bath tub molding machines. They are built very heavy, since unskilled labor is employed to operate them and unless well constructed, the constant jarring will soon result in getting the machines and flasks out of alignment. The severe treatment which these machines receive is well illustrated by citing the rapping of the cope pattern, which is done with a sledge, and the sand remaining in the cheek after leaving the shaking-out machine is knocked out with a billet of wood similar to that used by a street paver, with the striking end protected with an iron band.

Cope Flask.

The cope flask is shown in Figs. 1 and 2. It is made with trunnions A, set slightly above the center of gravity, so that when handled with a crane it will assume its normal position, as shown in Fig. 1. This casting is not machined unless it is warped when it comes out of the sand. Its location upon the cheek, Figs. 3, 4 and 5, does not necessarily have to be very accurate, a ¼-inch allowance being permitted. The cast lugs B, Fig. 1, project about 1 inch below the bottom line of the cope and engage the cheek at CC, Fig. 4. On account of this loose fit, the cope is fastened to the cheek by the clamps F, shown in Figs. 11 and 12. The wedges are cast integral with the cope and cheek and are shown at D and E. The wedging action takes place at the top and bottom so as to hold the flask firmly together. It will be noted that ample draft is given this casting to facilitate drawing, since it need be only a rough casting at best. It has a uniform thickness of ¾-inch and is usually about 6 inches high. In its truest sense this casting is not a cope flask, but is in reality a part of the cheek flask, since when once in place no parting is provided for, nor is it lifted off until the mold is poured. In fact, it is more of a pouring basin, which is set on after the cheek is rammed.

Cheek Flask.

The cheek flask is shown in Figs. 3, 4 and 5. The holes shown in the side elevation are provided to permit the escape of the gas and vapor from the sand and effectually prevent blow-holes in the castings. These holes are all cored in place and have no regular order of arrangement. The molder merely uses stock cores, preferably ⅝-inch round, and sets them in place in a similar manner to button cores for a bearing. The same provisions are made in the drag flask. This casting is subjected to severe treatment by the molder or laborer who shakes out the flask, and it is a common occurrence to find the cheek broken as the result of knocking out the sand. The practice is to make the body of ¾-inch metal and to cross-rib it all around, as shown at H. Provision is made at I for the pouring gates by offsetting the flask. This saves considerable sand all the way around which would otherwise have to be rammed. As shown in Figs. 11 and 12, the mold is poured from the bottom, which necessitates placing the gates outside of the rim of the tub mold. Openings for the crane hooks for lifting the mold from the machine are shown at J. These are spread far apart to steady the lift. The trunnions, KK, are used when placing the cheek on the machine or for turning it over. These trunnions must project out far enough so as to permit the crane hooks to clear the trunnions on the cope flask. Openings for locating the cheek accurately on the cope machine so that it will match up with the drag, are shown at L. These holes should all be drilled to one template, shown in Figs. 20 and 21. The wedges for clamping the cheek to the drag are shown at M. No wedges are provided on the cheek machine, Fig. 8, as it is not turned over and the weight of the cheek is more than sufficient to keep it from raising when being rammed. The top of the cheek flask is not planed, since the unfinished cope flask is clamped. The bottom, however, must be carefully



FIGS. 1 AND 2—PLAN VIEW AND SIDE ELEVATION OF COPE FLASK

machined, as it forms a parting and the template holes are drilled from this surface. Hence there must be no rocking when the cheek is p'aced on the cheek machine or when placed on the drag.

Cope Match Plate.

Figs. 6 and 7 show in detail a match plate for a five-foot bath tub, cope pattern. In Figs. 11 and 12 it is shown in position at A. It is planed on the top and bottom so as to provide a correct parting line on the top rim. This must be done accurately for thickness and it must be out of wind or it will spring under the heavy ramming and defective tubs will result. The cross bars are used to tie the planed ring and need not be machined. The only edges planed are the projecting ends or lugs which locate the match plate on the cope machine, Figs. 8, 9 and 10. The pattern is fastened to the match plate with countersunk head screws through the rim, and as the head comes under the roll the finish for enameling is not essential. This must be done securely, as the projections, NN, Fig. 6, are also used for rapping. A cast iron hood, O, is held loosely by a single bolt and is hit a few blows with a sledge. This hood acts as a protection for the match plate ring similar to the steel cap used on sheet piling. This ring is usually made two or three inches thick and in other dimensions to suit the particular size and design of the tub desired.

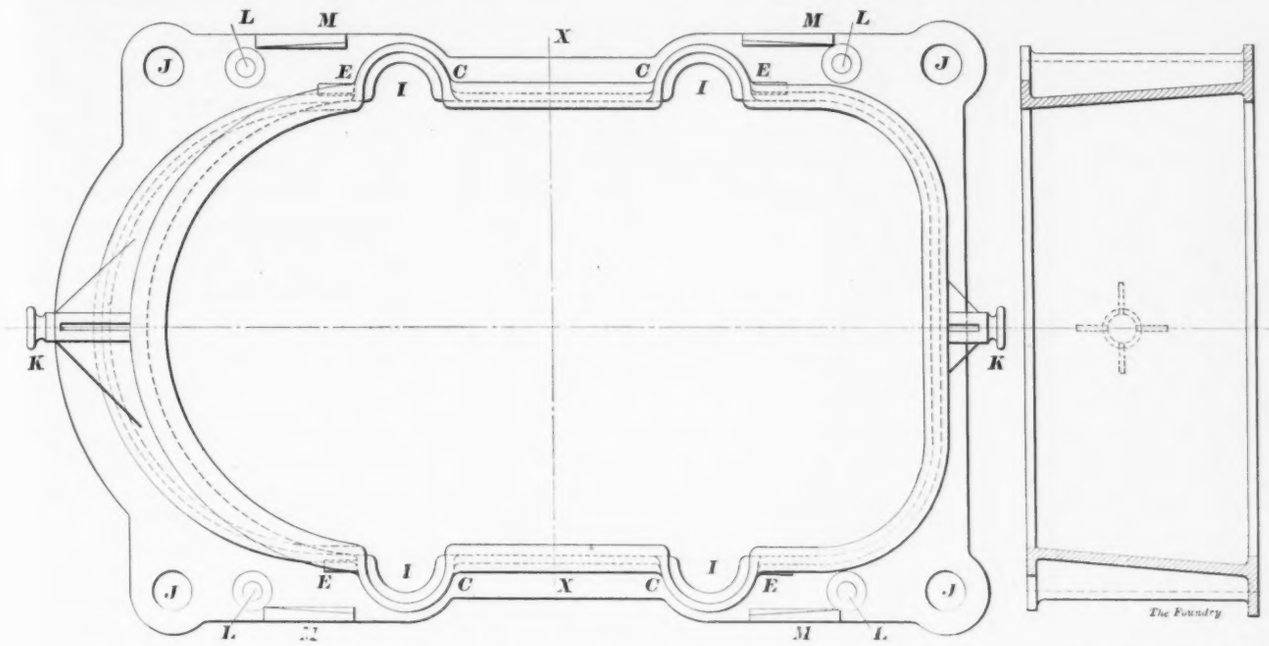


FIG. 3—PLAN VIEW OF CHEEK FLASK

FIG. 5—SECTION THROUGH XX, FIG. 3

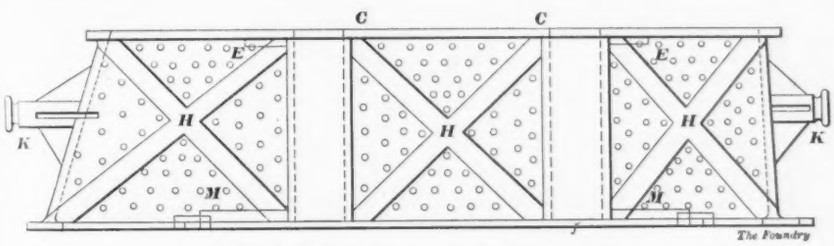
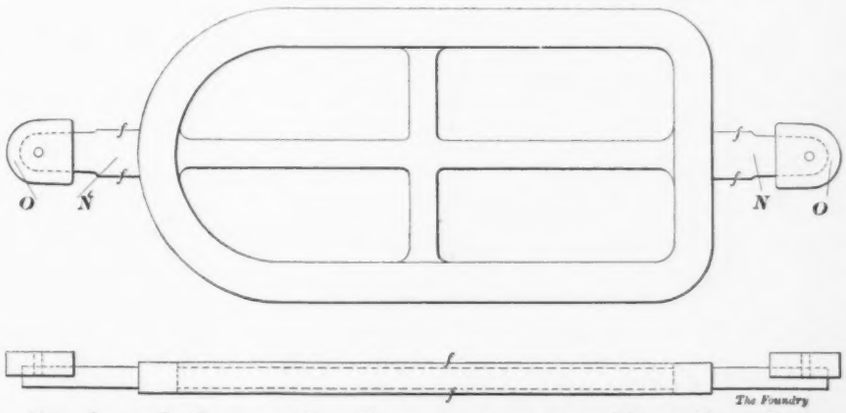


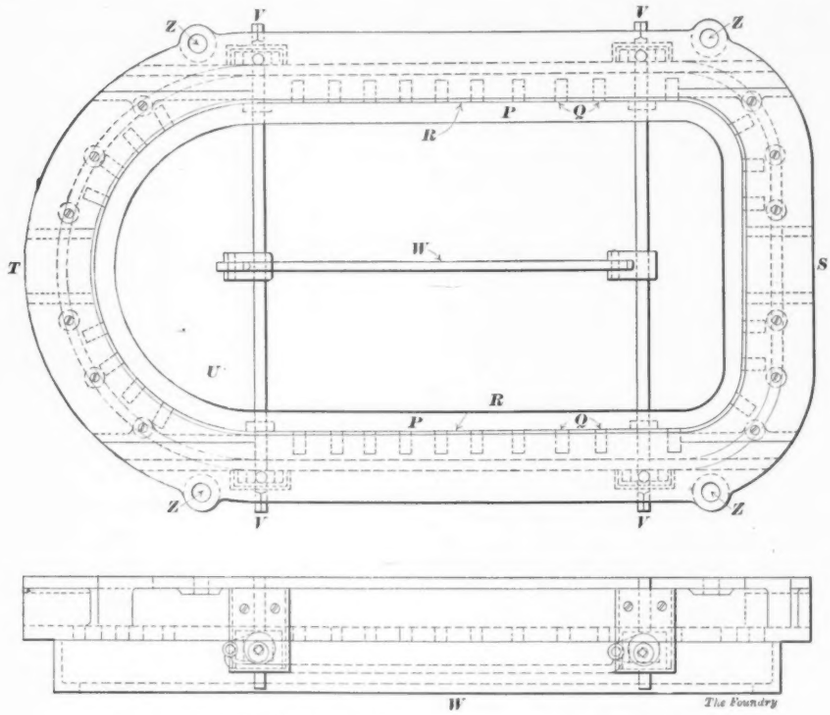
FIG. 4—SIDE ELEVATION OF CHEEK FLASK

The cheek molding machine is shown in Figs. 8, 9, 10 and 13. The match plate has been removed, but the ledge P, to support it, is illustrated in Figs. 8 and 10. This ledge is planed and openings, QQ, are provided around the machine to permit sand to flow through and to prevent it from working between the tub and the edge R of the machine. It will be noted that the top and ends are provided with detachable parts S and T. These are arranged to facilitate the planing of the edges RR, as a straight cut can be made lengthwise and the whole machine planed at one setting. The edges RR must be machined to a gage which is the exact width of the bath tub patterns. The edges of parts S and T are filed to fit the proper template that was applied to the rim of the tub and described in the July number of THE FOUNDRY. These parts are fastened to the main frame with fillister head cap screws and are lo-



FIGS. 6 AND 7—PLAN AND SIDE ELEVATION OF THE COPE MATCH PLATE RING

cated to come under the flange of the cheek, and not out where they will come in contact with the molding sand. In the end view, Fig. 13, and the sectional view, Fig. 10, they are marked finished to fit the match plate ring.



FIGS. 8 AND 9—PLAN AND SIDE ELEVATION OF CHEEK MACHINE

At V, Fig. 8, is shown the lifting shaft for raising the cheek, after being rammed, away from the pattern, Fig. 12. These shafts extend underneath the machine and are connected with the link W, so that they may be operated in unison. They are babbitted in place at X, Fig. 10, and the cap Y is used only as a dust cover to enclose a brass yoke and a steel eccentric. This eccentric is a flat, steel disc keyed to the shaft, and in revolving 180 degrees raises the brass yoke, and this in turn lifts the cheek. The movement of the yoke is from 2 to 3 inches and is intended only to release the sand in the mold from the pattern. A traveling crane is then used to finish the lift and for other subsequent operations on the cheek. After being rammed, two molders raise the cheek by hand with a cast iron socket wrench, the handle of which is at right angles to the square opening. The two wrenches are applied at diagonal corners to insure a uniform lift, even when the link W is worn. The openings Z, Fig. 8, are used to locate the cheek and are drilled with a template common to the cheek and drag flasks and the drag machine.

In Fig. 11 is shown a cross section of the cope pattern resting on the match plate ring a, and the pattern has been locked accurately by its own rim in contact with the flange R. The four sprues b, which taper from ¾ to 1¼ inches in diameter at the pouring basin, are shown in place. The sand is rammed entirely around the exposed surface of the pattern in the cheek, and when the cope is in position it acts as a support for the hanging sand and as a pouring basin. When the cope is off, the cheek has one large opening at the top, and as no bars are used, the molder can consequently ram up the mold much more rapidly than if the cope were an integral part of the cheek. The cheek and cope, lifted by the brass yokes, are shown in Fig. 12. As a very slight clearance is left between the sides of the mold and the pattern, one would think this the source of many broken-down molds. In practice, however, a molder steadies each end as the crane lifts away, and it is seldom that a cheek is lost from this cause.

The drag flask is shown in plan in Fig. 14, side elevation Fig. 15, and in section in Figs. 17 and 19. This should be heavily constructed, and as it receives its severest treatment on the central pyramid c, where it is struck for shaking out the sand, this should be strengthened above the average section. Usually, this flask is made 1 inch thick and frequently it has ribs extending vertically, giving equal strength but reducing the weight. Section c is suspended by the ribs d and is also hollow in the center. This is to permit the sand to be placed in the drag through the bottom in the position shown in Fig. 17. No sand should be filled into the cope pattern until the drag is clamped in place. This, however, is easier said than done, as it is a great temptation to the molder to throw in a thin layer of sand when the cope is off instead of shoveling it through the openings provided. If this practice is permitted to continue, the layers of sand thrown in from time to time gradually increase with each mold that is made, until finally the drag rests on the sand in the center and is sprung down to the parting on the machine by driving the clamps into position. It can readily be appreciated that this, at best, produces a distorted tub and frequently a thin tub is made. This trouble is frequently difficult to locate, as the machine and pattern may be perfect and the only remedy, if persisted in, is to discharge the offending molder.

The drag flask is planed only on the parting line, but this must be done as carefully as for the cheek flask. The locating holes are drilled by the template shown in Figs. 20 and 21, to match the cheek and drag machines. The ears, g, are set so that in closing the flask the crane hooks in the cheek ears do not interfere. They therefore cannot coincide and must also be set to clear the drag machine. From the plan views of the machines it will be seen that the cheek and drag will clear in all possible combinations. The wedges are shown at hh. These must all come in line so as to clamp to the cheek and drag machines, as the drag is rammed upside down and is turned over before lifting. The trunnions are

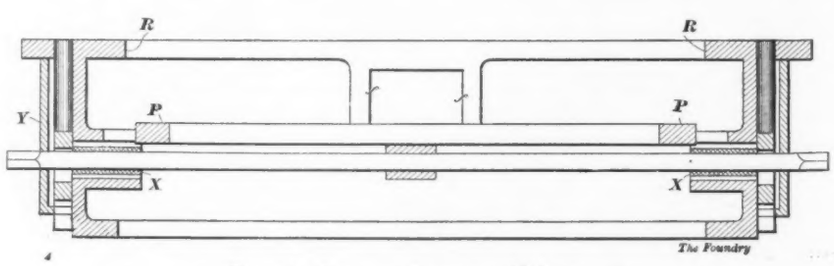


FIG. 10—SECTION THROUGH VV, FIG. 8

used in handling the drag when it is empty, being turned over before it is placed on the drag machine. The pyramidal part is provided with vent holes similar to the cheek.

The Drag Machine.

The drag machine is shown in Figs. 16, 17, 18, 19, and in Figs. 16 and 18 the tub is indicated by the dotted lines j and k, while it is shown in section in the other two views. The machine is made up of several parts, the trunnions being separate castings bolted to the main frame, while the round ends, for attaching the crane hooks, are held in place in the trunnions with cross keys. These may be straight or offset, so as to be in the center of the line of gravity when turning over the machine and the rammed drag. The trunnions l l should be slotted out in the pattern to clear the lifting rods nn. The bottom, o, is provided with a finish strip, and when planed is bolted to the main frame. The three openings, p, are provided for pouring the plaster of Paris around the pattern. The runners, qq, are secured in place after the tub pattern is in position. The center slot is provided to facilitate breaking off of the gate after the tub has been cast, and also retards the flow of the metal, and eliminates the liability of the sand on the rim to wash away at these points. The wedges for clamping the drag to the machine are shown at rr and the locating holes at ss. The lifting mechanism is shown on the outside of the machine. The same type of yoke and eccentric are used as on the cheek machine, together with the dust box, and the links are extended out still further so as to insure the operation of all of these parts in unison. Projecting lugs are suspended from the upper flange to carry this mechanism. The main frame is planed top and bottom, and as the top is the parting, it must be machined accurately. The prevailing thickness is ¾-inch of metal and the height and width conform to the size and style of tub to be made.

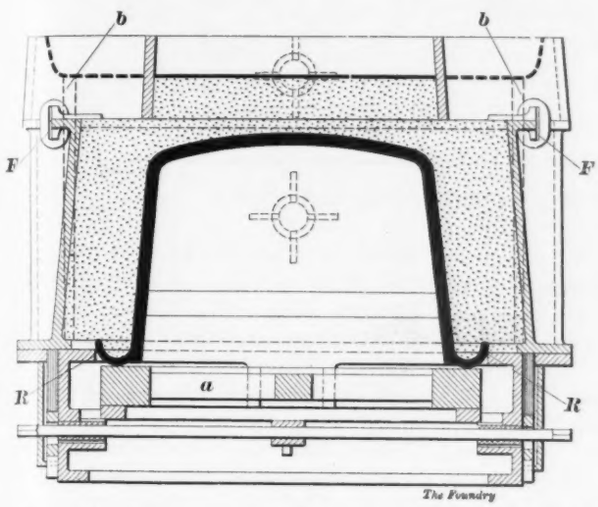


FIG. 11—CROSS SECTION THROUGH COPE HALF OF MOLD AND THE COPE MACHINE

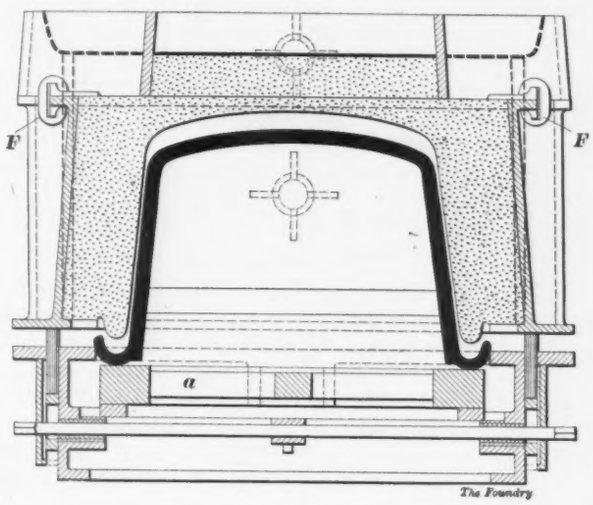


FIG. 12—CROSS SECTION THROUGH COPE HALF OF MOLD SHOWING THE LATTER LIFTED

Drilling Template.

The drilling template is shown in plan in Fig. 20 and in section in Fig. 21. It is ¾-inch thick for the webs, 3 inches wide and 2 inches deep. This template is used for drilling the locating holes in the machines, as well as in the cheek and drag flasks. A bushing, having an opening 1¾ inches in diameter, is inserted for drilling the cheek flask; one, 1⅝ inches in diameter for the drag, and another 1½ inches in diameter for the machines. The closing and locating pins are made of steel of various sizes to fit these openings.

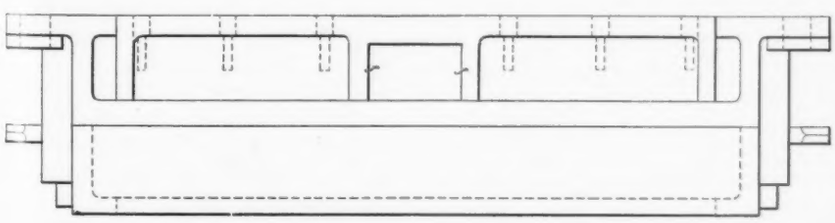


FIG. 13—END ELEVATION OF COPE MACHINE

Mounting the Patterns.

Mounting the cope pattern is a simple operation. After the flange R, Fig. 11, has been machined and fitted to conform to the template gage for the rim, the match plate is placed on the machine, and the holes having been previously bored and countersunk, the match plate ring is drilled and tapped. The screws are then inserted, the heads waxed, and since the flange R does all the locating, the machine is complete.

Mounting the light or drag pattern is more difficult and it is usually mounted before the cope pattern. After it has been filed and machined, it is turned upside down on the cope machine in a position similar to that shown in Fig. 16, with the heavy pattern in place. The match plate is used for fixing the parting line on the rim. The rim of the light pattern will come exactly to the parting if the tub has been properly filed and the machine finished to the proper height. The main frame of the drag machine, with its full equipment, is then raised and turned over the light pattern on top of the cheek machine. The locating holes are used to locate the machines upon each other. If the surfaces fit accurately, the light pattern is drawn up against the drag machine. This is done with two light, perforated lugs, Fig. 17, cast on the bottom of the tub pattern, and being in line with holes pp, Fig. 18, the pattern can be brought up against the parting. With the bottom plate, o, in place the cavity is next filled with plaster of Paris. This is prepared with water in an ordinary two-gallon,

wood bucket and is poured into the cavity as soon as it is mixed. It need not be very thick, but of the proper consistency to permit it to readily flow out of the bucket. The plaster holds the pattern in place, and as it is not exposed, the pattern very seldom becomes loose. As this is the light pattern, the plaster, in addition, acts as a reinforcement and makes the light pattern almost as solid as the heavy pattern. Twelve hours will, in most cases, be ample time for the plaster to set. The drag machine is then removed, the brass gates, qq, screwed in place, and the machines are tested.

Making the Mold.

For making the molds, two men are used on each machine, that is, two on the cope and two on the drag. A counterbalanced, pneumatic rammer is used and the daily output for a gang of four men averages from 24 to 28 castings. The sequence of operations on the cope machine is as follows: The sand is brought to the operator by a conveyor, having previously been riddled and tempered. The cheek flask is next brought to the machine by a crane and is set in place and the sprues are fixed in position. Sand, to a depth of about 6 inches is shoveled into the flask all around the pattern and is rammed with pneumatic rammers. This is continued until the cheek is rammed level with the top. The cope is then placed on the cheek, clamped, and the sand is rammed in the cope flask. The pouring basin is then formed, the match plate is rapped with a sledge, the sprues removed, and the cheek lifted from the machine, as shown in Fig. 12. By the use of a crane the cheek is lifted clear of the pattern, and if after inspection by the molder the mold is perfect, it is immediately placed on the drag. If slight patching is required, this is done while suspended from the crane. If considerable patching is necessary, either the mold is made over or it is carried to a frame where the molder can get underneath and repair it. No patching should, however, be necessary, if the machine and pattern work properly, and in some factories the mold is either immediately destroyed, or only patched while suspended from the crane. The reason for this is that the other operators, especially if a crane is serving five sets of machines, will not permit one molder to hold up the crane any length of time, as the tubs are made by piece-work.

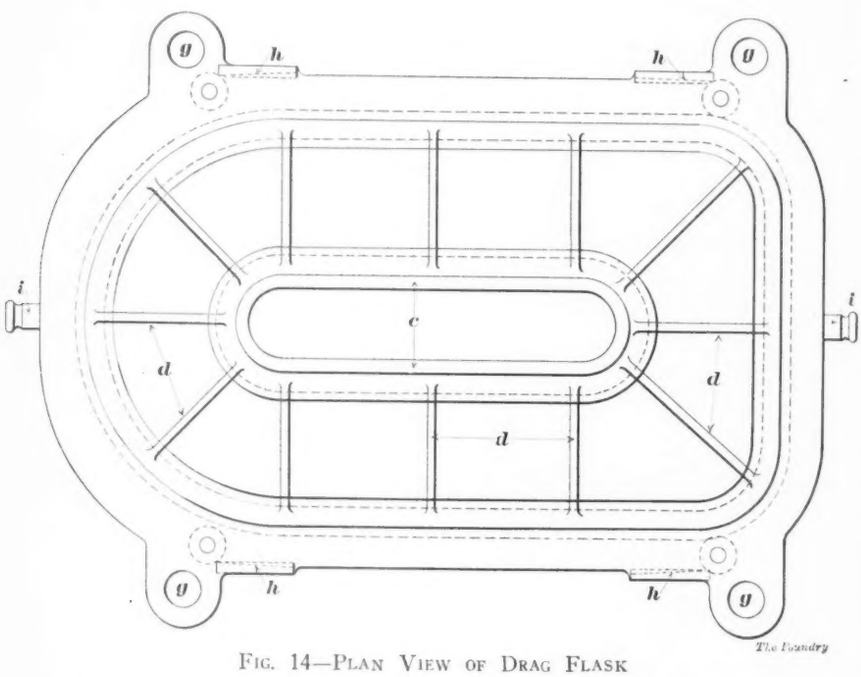


FIG. 14—PLAN VIEW OF DRAG FLASK

The Drag Mold.

The sequence of operations necessary for making the drag mold is as follows: The machine having been turned over from the previous operation, the drag flask is placed on the machine, clamped in position, the sand is shoveled into the flask, the ramming being done with pneumatic rammers. No bottom board is used, as the large amount of draft provided obviates this. The entire mass is lifted and turned over by the crane and the operators. It is then lowered to the floor, and the machine is lifted away from the drag after the clamps have been removed, and the brass yokes have been brought up by hand. The crane then turns over the machine and sets it in position ready for the next drag mold. The drag mold, previously made, is then carried to another part of the floor in position to receive the cheek. On its return to the drag machine, the crane carries a drag flask to the operators, sets it in position, and the operation is again repeated. A single crane will easily handle 125 molds daily. Two chain men, as well as other laborers, are required to shake out, pour and wheel the tubs away to the cleaning room.

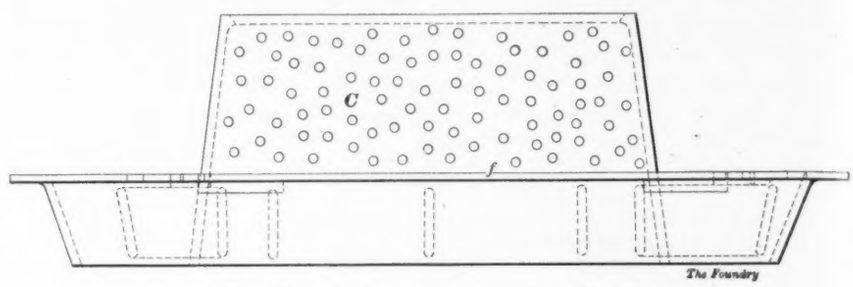


FIG. 15—SIDE ELEVATION OF DRAG FLASK

STEEL CASTINGS.

At a recent meeting of the Engineers' Society of Western Pennsylvania, held at Pittsburg, steel castings and the difficulties experienced in their manufacture were discussed at length. It was stated that high shrinkage is detrimental in many ways and frequently results in shrinkage cracks due to the uneven distribution of the metal, but which might easily have been avoided in the design. Castings which are open at one end, such as U sections, are apt to spread as the intervening sand will hold them apart, dry sand naturally forming a greater resistance than green sand. This trouble is remedied by either allowing for such spread in the pattern, by closing in the free ends under a press, or by connecting them with extra metal which is removed as soon as the casting has cooled. This is frequently resorted to, to hold the pedestal legs of

locomotive frames in place. When making driving wheel centers and similar castings, consisting of rims and spokes, the latter cool more quickly than the rim and if not prevented from doing so by covering with sand,

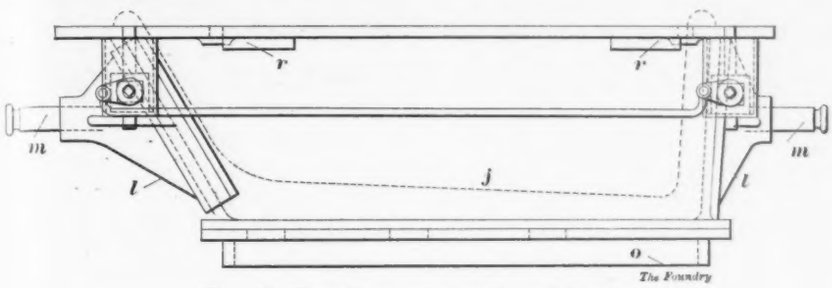


FIG. 16—SIDE ELEVATION OF DRAG MACHINE

will frequently produce cracks. Another result of this high shrinkage is the piping of castings which cool and reduce in volume while the source of additional metal is cut off. Large gates and high heads usually obviate this trouble.

G. W. Smith, vice president of the Union Steel Casting Co., Pittsburg, stated that some foundrymen buy cheap scrap and cheap material and expect the furnace men to give them a good grade of steel, and wonder why the castings are not solid and free from hot cracks. He added that formity of section or a gradual change of cross section is desirable. Annealing reduces the internal stresses. To avoid shrinkage cracks or checking in inside angles, fillets should be made larger than are necessary for cast iron, but should not be large enough to cause the metal to be much slower in cooling in the angle than in the adjoining parts. Although open-hearth steel castings are successfully made less than ½-inch thick, in forms that favor the flow of molten steel, it is good practice to make the minimum thickness ½-inch, and 5/8-inch or more is better. When the sizes of cores for holes are specified they should be made larger than is necessary for cast iron, as the molten steel cuts or penetrates the sand, thus leaving the hole smaller than the original size of the core. It is better to specify the desired diameter of the opening required, giving the size of bolt or rivet to be used. Due to variations in shrinkage, a liberal allowance should be made where possible for variations in dimensions and for finish where machining is necessary.

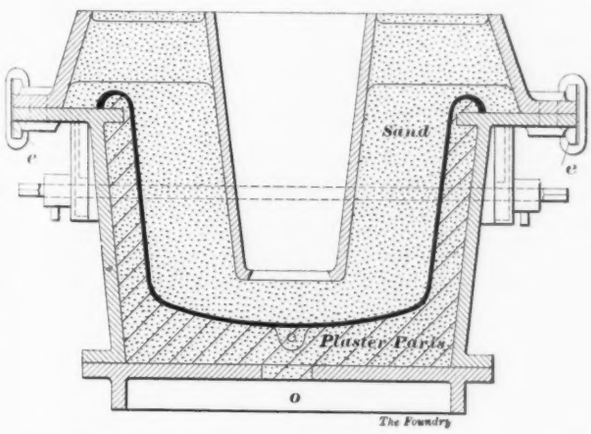


FIG. 17—CROSS SECTION THROUGH DRAG HALF OF MOLD AND DRAG MACHINE

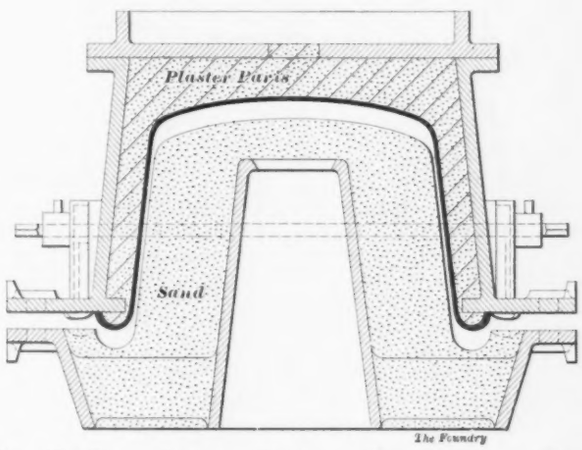


FIG. 19—CROSS SECTION THROUGH DRAG HALF OF MOLD SHOWING THE LATTER LIFTED

this method is wrong, especially with acid furnaces. If cheap scrap is the furnace charge, cheap castings will be the foundry output.

Shrinkage.

John Allison, engineer, Pittsburg Steel Foundry Co., Pittsburg, on the subject of shrinkage, stated that in steel castings it varies from 1/8-inch per foot to more than ¼-inch per foot, depending in large measure on the thickness and shape of the casting. To avoid internal stresses, uni-

Electric Furnace for Cast Steel.

The utility of the electric furnace for producing steel castings of intricate shapes and of very thin section was briefly touched upon by J. S. Unger, manager of the research laboratory of the Carnegie Steel Co. He called attention to a steel casting, a fork for a bicycle, 6 inches long, with walls not more than 1/8-inch thick, cast from steel made in an electric furnace. This specimen was sawed longitudinally and failed to show a single cavity. He called attention to the fact that it is possible to raise the temperature of steel in an electric furnace to such a high point that it will flow in as thin a wall as that required for the bicycle fork, while the reducing action of the electric furnace prevents many of the gases from being occluded. Flask annealing, he stated, might be of some benefit, but he did not believe that as good results were obtained as by removing the casting from the flask and reheating it to the proper temperature and allowing it to cool slowly. Ordinary large castings, after they have been removed from the sand, are heated up to 900 degrees Cent., and held at that temperature to allow the casting time to lag. This gives the grains time to rearrange themselves and allows for that chemical change in the carbon which occurs to a greater or less extent. After the casting has reached 900 degrees Cent., this temperature should be maintained for approximately one hour and a half or two hours to be certain that the change has taken place. When the casting shows no visible color in the furnace it should be removed and allowed to cool in the air. The additional cooling in the furnace is of no benefit to the casting, and it only holds the furnace back from further use.

Tests of Steel Castings.

On the subject of tests, T. D. Lynch, engineer of material tests, Westing-

house Electric & Mfg. Co., Pittsburg, said that it is necessary to take tests that represent the casting in its finished state. If the casting is annealed, all test pieces should be annealed with the casting. If the casting is not annealed, the test pieces should not be annealed, and any casting is dangerous that has not been annealed. The coupon test is a very usual one to make, and the lower it is placed on the casting the better the coupon will be, provided the feeding is good, and the coupon so located is less liable to contain blow holes and sand holes On the other hand, the nearer the cope the coupon is placed the more subject it will be to flaws and segregation. The design of the casting in general should be such as will permit of its being fed readily from one or more risers. The riser should be large enough to remain in a liquid state until after the casting itself has solidified. In the manufacture of heavy castings, he added that it was their practice, in order to avoid shrinkage cavities, to make the riser equal in size to that of the casting itself. In these massive castings it has been found advisable to take the test pieces from the body of the casting itself, after it has had its final treatment, by drilling them from the solid casting. By so doing it is believed that a real test is had representing the steel as it would be under working conditions.

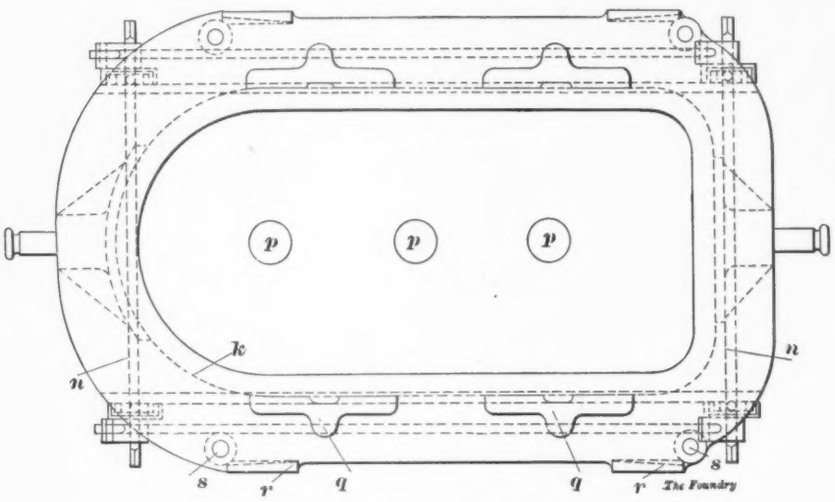


FIG. 18—PLAN VIEW OF DRAG MACHINE

USE OF MICA IN BRASS.

Question:—We are interested in a process for melting brass with mica by which it is claimed castings are given a higher finish and become noncorrosive. Can you give us any details regarding this process?

Answer:—Brass cannot be improved by melting with mica. The latter is a silicate of aluminum and potassium and neither silicon, aluminum nor potassium are desirable additions to red brass, even if it were possible to alloy them therewith by melting the brass with the aluminum. In melting down insulated wire I have never noticed any difference in the metal, even when the crucible has been half filled with mica. The latter has proved a big nuisance and it has always been desirable to remove the same from the wire before attempting to melt the latter. In melting an accumulation of scrap brass containing iron in the shape of screws and rivets, copper was added in the form of commutator chips, and the resulting metal, to our surprise, was clean, and it was believed that the mica dust, of which the chips contained a large percentage, had fluxed out the iron. Subsequent experiments, however, did not sustain this view. Mica dust was added as a flux to scrap containing iron, but the result was the same as if no mica had been used. If your castings do not take a high grade finish the mixture is at fault and should be changed, or the metals used are not clean. K. K.

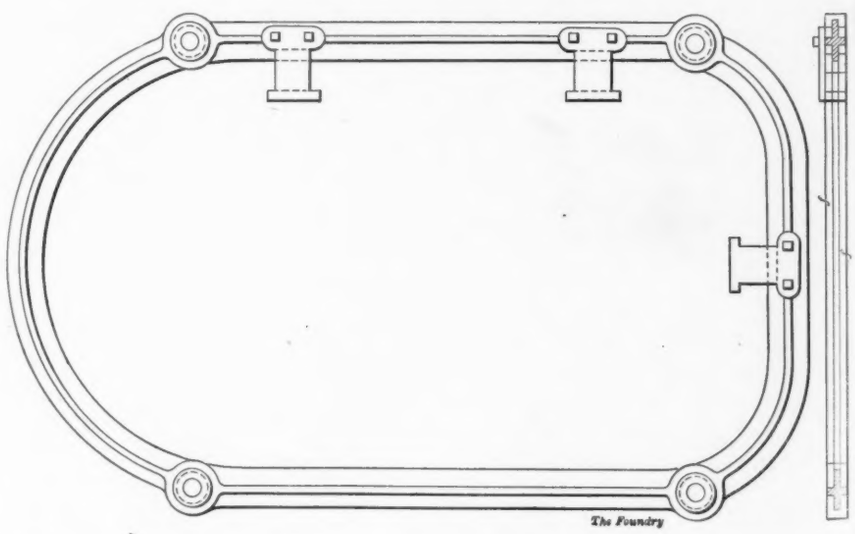
INSTITUTE OF METALS.

The autumn meeting of the Institute of Metals will be held on Thursday and Friday, Oct. 14 and 15, at Manchester, England. A number of papers will be read and discussed at the two morning sessions, and on the afternoon of the first day a visit will be made to the University of Manchester where an inspection will be made of the new engineering laboratories. During the afternoon of the second day the members will be afforded an opporttunity of visiting works of metallurgical interest in the vicinity of Manchester. During the first year of its existence the membership has grown from 200 to more than 500, and the indications are that this will be still further increased before the annual meeting is held. The vacancy in the vice presidency caused by the death of Norman Cookson, of New Castle-on-Tyne, has been filled by the council, which at a recent meeting unanimously elected Dr. H. C H. Carpenter, of Manchester.

MIXTURES FOR BENDING BRASS

Question.—We would like to secure a mixture for brass castings that will bend about 45 degrees, after they are finished, without fracture.

Answer.—We can recommend the following alloys: (1) copper 92, tin 5, zinc 2 and lead 1; (2) copper 75, zinc 8, tin 3, lead 2. K. K.



FIGS. 20 AND 21—PLAN VIEW AND SIDE ELEVATION OF TEMPLATE FOR DRILLING LOCATING HOLES

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TWENTY-FIVE YEARS OF CAST IRON*

A discussion of the knowledge of the properties of cast iron in 1884 and the wonderful progress recorded in the last quarter century

BY PROF. T. TURNER

THE more general application of accurate chemical analysis to metallurgical processes dates from the foundation of the Royal School of Mines in 1851, and already in 1856 a very important series of chemical analyses and mechanical tests of cast iron was commenced at Woolwich Arsenal by J. Spiller. The introduction of the Bessemer process for steel-making at about the same time gave a great impetus to the work of the analytical chemist. The result was that analyses multiplied, but as the chemist was dealing with six variables, viz., graphitic carbon, combined carbon, silicon, sulphur, phosphorus and manganese, the effect of no one of which was accurately known, it followed that the advice of the chemist was of little value, and was indeed very frequently misleading. The position was admirably expressed by Dr. Percy, in his presidential address to the Iron and Steel Institute in 1885, in the following language:

"It is not many years since we had to grope about to discover an analysis of iron ore or of pig iron, whereas, now we are actually overwhelmed with analyses. We are deluged with percentages of carbon, graphitic or combined, of silicon and manganese, of sulphur and phosphorus. We are bewildered with the vast accumulation of materials, like the traveler in the mazes of a primeval American forest. What is now wanted is the man to reduce it to law and order, to evolve from it principles for our sure guidance."

It will thus be seen that analysis had failed to yield that information which the practical man desired, and this failure was due, not to the errors of analysis, but to the want of information which was necessary in order to rightly interpret the analytical results obtained. It appeared, therefore, that the proper method of attack was by synthesis, or in other words, to prepare a series of irons in which one element was caused to increase by definite steps, while all the other constituents were kept, as nearly as possible, in normal and constant proportions. To carry out such a scheme fully, would evidently involve an enormous expenditure of time and labor, and the question had to be decided which element was likely to lead to more immediate results, and to give the greatest information. The choice fell upon silicon, and events proved the selection to have been a most fortunate one.

The first research undertaken was that relating to the influence of silicon on the properties of cast iron, the object being to prepare a series of test bars of a standard and commercial size from a series of mixtures in which silicon was the only varient. At present this is tolerably easy, as washed iron forms an excellent base, while ferro-silicons can readily be purchased with upwards of 50 per cent silicon, and silicon is itself commercially obtainable. But in 1883 the highest ferro-silicon not rich in manganese, which was made in the blast furnace contained about 10 per cent of silicon. Even this metal contained nearly 2 per cent of manganese, and some months were spent in a preliminary attempt to remove the manganese without eliminating the silicon. It was proved that by all the methods examined the silicon and manganese were oxidized together and ultimately the idea of purification was abandoned. A further difficulty arose from the fact that, with 10 per cent of silicon, the maximum proportion of carbon which the iron can take up and retain is about 2 per cent, hence it became evident that one end of the series must of necessity have only 2 per cent of carbon instead of 3 or 3.5 per cent, as in ordinary cast iron.

Two alternatives suggested themselves, either to saturate each melt with carbon and so pass gradually down the series from 3.5 per cent at the one end to 2 per cent at the

PROF. T. TURNER

*Presented at the Birmingham convention of the British Foundrymen's Association.

other, or to prepare a base free from silicon, but with 2 per cent of carbon. The latter procedure was selected, and "pure cast iron" was made by heating wrought iron in crucibles with charcoal. The product was white cast iron containing about 2 per cent of carbon, 0.19 per cent of silicon, 0.32 per cent phosphorus, 0.14 per cent manganese, and 0.05 per cent of sulphur. The test pieces employed were round bars 1⅛ inches in diameter, and about 20 inches in length over all, so as to allow of a clear foot in the middle of the bar for accurate measurements. The tests included tensile strength, crushing strength, density and hardness, while observations were also made upon the relative fluidity, smoothness of surface, shrinkage in the mold and character of fracture. The transverse strength was also calculated.

Important Observations.

Perhaps the most important observation was that metal with less than 1 per cent of silicon was white, hard, and brittle; it possessed a rough surface, contracted considerably in the mold, and generally was full of blowholes. It was, therefore, quite unsuited for the ordinary work of an iron foundry. With about 1 per cent of silicon the metal was sound, and had a high crushing strength, but was too hard to turn or machine. With from 1.5 per cent to 2.5 per cent of silicon the metal was soft, sound and gray, while the maximum tensile strength was obtained with rather less than 2 per cent of silicon. With such silicon content the metal was admirably suited to all the usual requirements of the foundry, but for greater fluidity more silicon was found advantageous, though the metal suffered in strength by such addition. With still higher silicon the metal became weak and brittle, while the hardness at the same time also somewhat increased.

Influence of Silicon on Carbon.

It was pointed out that the effect of silicon on cast iron was two-fold: First, that due to the silicon itself; and, second, that resultng from its influence on the carbon present. The first effect is of a more uniform, but less definite character, and is similar in kind to that of any other element which unites with iron to form a solid solution, viz., the production of a material with greater tenacity, increased hardness, less ductility, and usually also lower melting point than that of pure iron. In this connection, the elements may be said broadly to differ among each other not so much in the nature or character of the effect which they produce as in the amount or quantity of that effect and the proportion of the added element which is needed in order to obtain the maximum benefit. It is also important to observe that the different properties of the metal, though usually altered in the same general direction by the addition of a foreign element, are not all altered in the same proportion. For example, both carbon and nickel increase the tenacity and hardness of iron and reduce its ductility; but since the ductility is diminished much more rapidly by carbon than by nickel, it is advantageous to use nickel when combined tenacity and ductility are desired. Many similar examples could be readily supplied and it is doubtless to some kindred action that part of the beneficial influence of silicon is due. Silicon also has a profound influence on the carbon which is present in cast iron. The carbon which is retained in solution in the iron during and after the solidification of the metal; makes the iron hard and brittle, but if this carbon, having been thrown out of solution, exists in the free or graphitic form, the iron is too soft and tough. Now, silicon dissolves quite readily in iron in the form of silicide, and while the limit of solubility of carbon in iron is about 4.25 per cent, there is no limit to the solubility of silicon. It would appear that silicide of iron does not dissolve carbon, or dissolves it only to a very slight extent, hence in iron which already contains silicon, the solubility of carbon is diminished, so that the total carbon present becomes less and less as the silicon increases.

Marked Effect of Silicon.

But the most marked effect of silicon is that which occurs with almost dramatic suddenness in the neighborhood of 1 per cent of silicon. Here the carbon, which was originally dissolved in the fluid cast iron, is thrown out of solution during the solidification and subsequent coolng of the metal and a white hard material is transformed into a casting which is soft and gray. As is well known, the actual proportion of silicon which is necessary in order to produce this truly wonderful change, will vary according to the proportion of other elements and the rate of cooling. In ordinary practice the rate of cooling is largely determined by the size of the casting, and hence for small castings more silicon should be added. We may here also so far anticipate later work as to mention that in gray cast iron which contains silicon the second arrest in the rate of cooling, observed in steel and in white cast iron in the neighborhood of 680 degrees Cent., is appreciably raised by each addition of silicon. In other words, silicon accelerates the formation of pearlite, and probably also its decomposition, and hence under suitable conditions leads to the production of finely divided or amorphous graphite.

The immediate result of the knowledge gained of the effect produced by various proportions of silicon, and indirectly also, of the influence of combined and graphitic carbon, was that many analyses, which had already been published, could be arranged and compared in order to determine the effect of phosphorus, manganese and sulphur. Hence it was concluded that the strongest and most trustworthy cast iron was not that which contained very exceptionally small proportions of phosphorus, manganese or sulphur, but that each of these elements, in suitable but different proportions, appeared to be beneficial. The main conclusions arrived at from these considerations were shortly afterwards confirmed by W. J. Keep, of Detroit, who, by methods which are well known now, studied the influence upon cast iron of silicon, phosphorus, sulphur, aluminum, and certain other elements. These researches occupied about six years, and are a model of careful and systematic observation applied to a definite and useful end.

Graphitic and Combined Silicon.

Before dealing with the practical applications of these researches, mention may be made of several other investigations made at this period. There was at the time considerable difference of opinion as to the condition in which silicon exists in cast iron. Many metallurgists of repute favored the view that silicon, like carbon, existed in two forms, the graphitic and combined. Dr. Tilden's experiments had led to a negative conclusion so far as graphitic silicon was concerned. The question was of great importance, because if silicon really did exist in two separate forms, it was necessary to separately determine the effect of each. In conjunction with one of my students, A. E. Jordan, a research was conducted and a considerable number of samples with varying percentages of silicon were examined by mechanical, magnetic and chemical methods with the object of separating

ments was briefly stated in April, graphitic silicon if such were ever present. The result of the experi- 1886, as follows:

"Silicon exists in cast iron in the form of a silicide (or silicides) which is dissolved when flu'd if an excess of iron is present." Hence it was useless to attempt to estimate the influence of silicon in two forms, and this conclusion has since been amply confirmed and is now generally accepted.

Remelting Iron.

It had long been known that iron which was remelted was somewhat changed during the process and that it usually became harder and stronger in consequence. Elaborate experiments had been porformed in which iron was remelted many times, or kept in the fluid state for lengthened periods, with the object of ascertaining the cause of the improvement which was observed. No general rule or principle had yet been observed and the difficulty was rendered greater by some misleading analyses which had been performed in connection with a series of tests conducted by Sir W. Fairbairn and which had been widely published. Originally I was misled by these figures myself, but fortunately Prof. Unwin had preserved samples of the original test bars and these were analyzed in Mason College, and checked by Mr. Walton, with the result that the theory of what takes place during remelting of cast iron was made quite plain. It was shown that with each melting, silicon is removed while sulphur is added; and the effect of these changes is to convert graphitic carbon into combined carbon, and hence to harden the iron. This is all so simple and well understood by every metallurgist now that it is difficult for us to imagine ourselves in the position of the iron founder of less than a quarter of a century ago, who did not know that silicon was diminished by each melting, or, if he had learned so much, would still have been quite at a loss to explain what would be the effect which a reduction in the percentage of silicon would produce.

Practical Application of Laboratory Results.

The experiments previously mentioned had afforded a standard for each of the elements which ordinarily occur in cast iron, but it yet remained to show that results obtained in actual practice agreed with the tests conducted upon a relatively small scale. The first step in this direction was the examination of analyses of specially excellent material from published sources, and also the collecting of specially good cast iron from friends, and analyzing the material so obtained. The result of the analyses and comparisons was to show that the proportions of combined carbon, silicon, sulphur, manganese, and phosphorus did not vary over any wide range in any of these specially selected and excellent samples. Another obvious method of putting the theories into practice was to actually make mixtures in the foundry in accordance with the suggested analyses.

Interest Manifested in Investigation.

The interest taken in cast iron at this time and during the next few years was truly remarkable, and was not confined to any one part of the British Islands, or to any single country. The work of Mr. Stead and of the late Charles Wood, of Middlesbrough, calls for special mention. At the Glasgow meeting of the Iron and Steel Institute in 1885, these authors gave particulars of the practical results of adding silicious iron in the foundry for softening purposes, and showed that very satisfactory castings were made at a reduced cost, over a period of three months, in a foundry which produced about 60 to 70 tons per day.

M. Gantier did much to interest the French iron founders in the subject, while Ledebur was a leading German authority, and Keep was doing brilliant work in America. My own correspondence included inquiries from almost every civilized country throughout the world. This widespread interest was the more remarkable because cast iron had already been superseded as a material for construction; the success of the Bessemer, the Siemens and the basic processes was fully assured, while America and Germany were rapidly increasing their production of steel. The renewed and extended interest in cast iron came as a surprise to those who believed the days of the iron founder to be numbered, and was a revival which was as unexpected as it was pronounced.

Physical Tests.

Returning now to the story of scientific discovery, it may be pointed out that this, in cast iron, followed the general lines which had been adopted with wrought iron and steel. The general order may be stated as being first mechanical, secondly chemical, and thirdly physical. The experiments hitherto recorded dealt with the mechanical and chemical properties of the material, but the microscope and the pyrometer had yet to be employed. Between 1893 and 1902 tentative work in this direction was undertaken by the late Walter MacMillan, at Mason College, and Royston's researches on malleable cast iron indicated that some good work was done, but it was not until after the University was established in 1900 that proper equipment was available for such investigations. The researches of Sorby, Roberts-Austen, Arnold and Stead had dealt with steel, but cast iron had only been incidentally touched, and no attempt had been made, so far as I am aware, to connect micro-structure with suitability for the many varied uses of the iron founder. Two important observations had been made, however, to which it is necessary to refer, even though this leads to another digression from the story of the work done in Birmingham. The first of these was by my old and much respected friend, the late Prof. Ledebur, who in 1889 had called attention to the fact that the graphite in cast iron is of two kinds, one of which is in flakes and the other in fine powder. These are now usually called primary and secondary graphite, respectively, and Ledebur showed that the latter variety is that which occurs in annealed malleable cast iron. The other investigation in 1900 was conducted by Mr. Stead and dealt with phosphorus in iron and steel. So far as cast iron is concerned, the most important conclusions were that phosphorus exists in iron in the form of a phosphide, Fe_3P_2, which in carbonless iron is in the form of a solid solution, and is therefore not visible under the microscope. But in gray cast iron the phosphorus separates in the form of a eutectic of iron and phosphide of iron, and this separated material is more fusible than the rest of the metal and can be readily seen under the microscope. The recognition of two forms of free carbon and of a phosphide of eutectic in cast iron were of the utmost value in connection with the microscope and thermal properties of the metal. The possession of a considerable number of samples of cast iron of known chemical and mechanical properties rendered the microscopical examination more systematic and more valuable. It was soon recognized that all hard cast irons contained cementite, while weak and soft cast irons contained graphite in a state of coarse division. The proportion of phosphorus can be roughly estimated in gray irons from their microstructure, and all soft, strong gray irons give a

close-grained, even structure with relatively small graphite and no large areas of phosphide eutectic.

Solidification of Cast Iron.

More recent work of an interesting character had reference to the volume and other changes of cast iron during and after solidification from the fluid state. There was at one time considerable discussion, with which the name of Mattel is associated, as to whether or not cast iron expanded during solidification. My attention had also been drawn to the fact that when iron is cast in chills the metal often cracks during the process of solidification and subsequent cooling, but that such fractures can be largely prevented if the mold is removed while the casting is still red hot and the metal is thus allowed to cool normally to the ordinary temperature. This fact pointed to a critical point in cast iron similar to those which had already been observed in the case of steel. The first accurate observations on the volume changes of cast iron were made by Mr. Keep, and it was shown that in some irons three distinct arrests in the rate of contraction or even three actual expansions, took place while the metal was passing from the fluid state to a dull or scarcely visible heat. The inquiry which was thus in a very interesting stage, was then taken up at the University of Birmingham, and tests were made with irons of varying compositions, by means of the extensometer and also with the pyrometer during the same intervals of time. We were now able to plot on the same chart two curves, one of which showed the changes of volume, while the other indicated the corresponding changes of volume. The reason for much of the uncertainty which had existed in reference to the expansion of cast iron during solidification was then made clear. It is now well known that most metals contract uniformly during solidification and show no irregularities during subsequent cooling. White iron closely resembles these metals, since it shows only one, relatively small, temperature arrest, and an almost negligible arrest in contraction during cooling. This single arrest occurs at slightly under 700 degrees Cent. Hence white cast iron does not appreciably expand during solidification, and the result is the well-known fact that a greater allowance must be made in the pattern for a hard than for a soft iron.

With gray hematite iron two very marked expansions are observed, while if phosphorus be present in addition to silicon there are three distinct expansions and three separate temperature arrests. The arrest due to phosphorus is in the vicinity of 900 degrees Cent., while that which occurs in the neighborhood of 700 degrees Cent. is somewhat raised and becomes much more pronounced in the presence of silicon. The presence of a small proportion of manganese appears to make this arrest and expansion still more marked, but this point is now under further investigation.

Importance of Chemical Analyses.

Though chemical composition is of great importance, analysis is only one aid to the scientific iron founder. If he is to succeed he must also know how the metal is affected by each element which is present, and how the ultimate mechanical properties are influenced by the many and varying physical conditions through which the material has to pass. While the founder formerly relied merely upon accumulated experience of brands and numbers and did not know the suitable proportion of the characteristic influences of the various elements which are present, he now knows with considerable accuracy the effect of every usual constituent. The condition in which each element occurs is also well known and the alterations which take place during remelting are clearly understood. Much light has also been thrown upon the changes which occur while the metal is solidifying in the mold, and the microscope has been applied so as to give a whole range of useful information as to the character and properties of the finished article.

Future Discoveries.

Remarkable as have thus been the increases of knowledge during the past quarter of a century, it must not be supposed that all has yet been discovered, or that any finality has been reached. In many directions we are as yet only in the gateway of knowledge, and for the young and energetic investigator who has the requisite training and skill the field is as wide as ever before. Rather, it should be said, it is wider, for every firm foundation securely laid is but a stone on which to build and through each doorway which has now been opened the earnest student sees long corridors as yet untrod.

In the article entitled, "Repairing Patterns," page 282, August issue of THE FOUNDRY, owing to a typographical error, the word "sheltered" in the second line from the end should have been "shellaced." Venice turpentine is recommended for this work, rather than common turpentine.

IRON IN COPPER.

BY C. VICKERS

It is a fact not generally known that iron is a powerful deoxidizer of copper, and that solid copper castings can be made by its use. The quantity of iron necessary to eliminate blowholes in copper is very small, and one pound added in the form of tin plate will deoxodize 250 pounds of copper. The castings will come out of the sand solid even when remelted.

Copper so deoxodized has been used for some time for making fingers and other contact parts of electric controllers with most excellent results, as such castings have proved to be almost as good as rolled copper. It was, therefore, believed that the conductivity of such copper would be high, but this was not the case, as was proved by the following tests. The fact still remained, however, that it gave most excellent service. The test bars were cast from scrap trolley wire and not from ingots. For the first test bar 100 pounds of copper was melted under charcoal, and when thoroughly liquid, two pounds of yellow prussiate of potash was thrown on top and the furnace closed for a few minutes to drive out the water of crystallization from the potash. The metal was then vigorously stirred and heated until the potash had ceased to give off fumes. The test bar A was then cast. The bar B contained one pound of tin plate to 250 pounds of copper.

Mark.	Diameter, inches.	Length tested, inches.	Conductivity, per cent.	Temperature, degrees Fahr.
A.....	0.623	12	53.92	80.0
B.....	0.623	12	41.18	80.5

GERMAN AND FRENCH ASSOCIATION OF FOUNDRYMEN.

Another organization of foundrymen has been effected in Berlin, Germany, the new association being known as the German Foundry Engineers' Society. Headquarters have been established at 60 Sybel-strasse, Charlottenburg, Germany. A call has also been issued for a meeting of foundrymen to be held in Nancy, France, on September 8. The subjects for discussion will be the work of the Cincinnati convention of the American Foundrymen's Association. It is probable that a society of French foundrymen will be formed at the time of this gathering.

The Cutler-Hammer Mfg. Co., Milwaukee, manufacturer of electric controlling devices, has opened an office in the Commonwealth building, Philadelphia.

EFFECT OF STRUCTURE OF CAST IRON*

Upon its physical properties--- Microscopic evidence of the reason why irons of similar chemical composition have different relative strengths

BY F. J. COOK AND G. HAILSTONE

DURING daily foundry practice with work made from mixtures of iron that have the same chemical composition, and where tests are frequently taken, it is often found that widely different physical results are obtained, although the ultimate chemical composition of the metal used has been practically the same. Instances of this have been brought to the notice of this association, notably in the paper read by Mr. Longmuir on "Theory and Practice" at the Sheffield convention. A remarkable instance was also given in last year's presidential address, but in neither case was any explanation of the phenomena given. Attempts have been made by several persons to give a satisfactory explanation of these differences, but, on the whole, the conclusions arrived at have not been generally accepted.

Noteworthy Series of Tests.

In the past the instances cited have generally been isolated ones, but a remarkable series over a lengthy period has recently been met with by one of the authors. Fig. 1 is a diagram of tensile test results of two series of casts, each representing 60 consecutive days' working, with irons mixed to give the same chemical composition, but each series made up with different brands of pig iron. That the chemical analysis was identical in each case was proved by analyses taken from time to time which, in each instance, for all practical purposes came out alike. The diagram shows that the highest tensile result in the A series was lower than the lowest result in the B series. A summary of the whole of the tests taken is shown in Table I.

Each tensile test bar was 1 inch square, and transverse and hardness bars were cast relatively of the same size and on the casting they were to represent, while the ½-inch transverse bars, which were also used for the shrinkage test, were cast separately by Keep's method. The transverse bars were cast 1¼ inches square, machined down to 1 inch square, and tested on 12-inch centers. Referring to Table I it will be seen that the results of the transverse tests on the 1-inch square bars also show a marked difference, as do the tensile tests. It will be noted, however, that the average result of the transverse test on the ½-inch square bars is slightly in favor of the series which gave the weakest tensile and 1-inch square bar transverse results. This point will be referred to later. As the methods of manipulation and the chemical composition of the two series had been the same, it was thought that a microscopical analysis would reveal a cause for the vast difference. For the first investigation a low bar of the A series, and the highest bar from the B series were examined. The chemical analyses of the two bars was first taken as shown in Table II.

Table I—Results of Mechanical Tests.

	Tensile test. Tons per sq. in.		Transverse tests, cwts., 1 in. sq. bar, 12 in. center.		Transverse tests, lbs. on ½ in. sq. bar, 12 in. center, Keep's test.		Shrinkage in inches, ½ in. sq. bar, Keep's test.		Hardness.		Blast pressure in ounces	
Series:	A	B	A	B	A	B	A	B	A	B	A	B
Highest	12.9	18.3	28.05	32.25	550	570	0.182	0.180	68	78	15	16
Lowest	8.7	13.1	19.0	25.0	390	375	0.144	0.140	48	56½	10	11
Average	10.7	15.8	23.1	29.1	466	450	0.140	0.155	57½	64¼	12¾	13¼
No of tests taken	60	60	33	30	58	59	58	58	60	56	44	39

Chemical Analyses.

These analyses will be seen to be practically identical, even to the amount of the combined and graphitic carbon. To insure the results being absolutely comparative, a number of micrographs were each taken from the same position, at the center of the bars. Fig. 2 shows the polished, but unetched section of the low bar from the A series; Fig. 3 the high bar from the B series. These show the size of the graphite in each case, the one having it in the form of long flakes, the other in very small flakes. Figs. 4 and 5 show the same surfaces etched with iodine and magnified 120 diameters. In the one case the large flakes of graphite are plainly seen in a matrix of cementite, phosphorus-eutectic, pearlite and ferrite; while in the other the graphitic carbon is scarcely visible and a closer structure

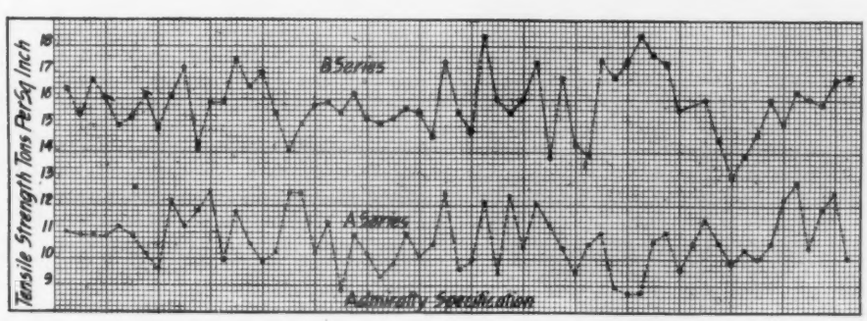


FIG. 1—TENSILE TEST RESULTS OF TWO SERIES OF CASTS EACH REPRESENTING 60 CONSECUTIVE DAYS' OPERATIONS

* Presented at the Birmingham, England, convention of the British Foundrymen's Association.

is observed. Otherwise there is nothing very remarkable to account for such widely different physical results.

The same surfaces were then treated on the lines laid down by Mr.

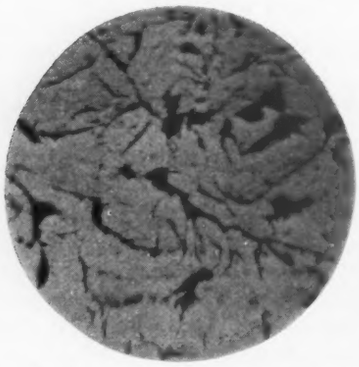


FIG. 2—A SERIES; TENSILE STRENGTH 18,200 POUNDS PER SQUARE INCH; MAGNIFICATION 120 DIAMETERS

Stead at last year's convention, to bring into prominence the phosphorus-eutectic. Fig. 6 shows the 9.1-ton bar and Fig. 7 the 18.3-ton bar. In

Table II—Chemical Analyses of the Two Bars.

Tensile test.	Series. A. 9.1 tons per sq. in. Per cent.	Series. B. 18.3 tons per sq. in. Per cent.
Total carbon	3.250	3.192
Graphitic carbon	2.397	2.289
Combined carbon	0.853	0.903
Silicon	1.328	1.314
Sulphur	0.095	0.101
Phosphorus	0.923	0.909
Manganese	0.290	0.335
Iron by difference	94.114	94.149

both cases not only is the phosphorus shown, but the cementite as well. In Fig. 6 the phosphorus and cementite are evenly distributed, and have not taken up any definite form of structure, the graphite being also shown intermixed with them; but in Fig. 7 a very remarkable arrangement of a net-like formation of the phosphorus and cementite is shown. As it had been noticed with bars previously examined, that those giving high test results had also been associated with this particular net-like structure, we were led to the conclusion that probably strength was associated with this structure independently of what the chemical composition might be. We, therefore, examined a series of bars made by one of the authors a few years ago to show the effect on strength of different rates of cooling. For this experiment four bars had been made in one box cast from the same ladle of metal, which was ordinary No. 3 foundry pig iron. The

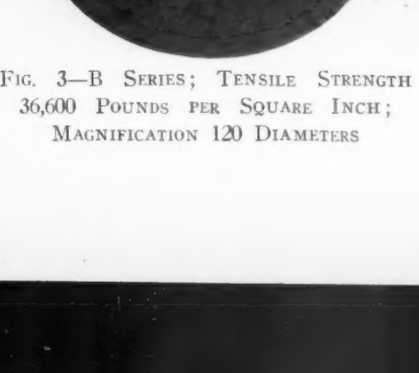


FIG. 3—B SERIES; TENSILE STRENGTH 36,600 POUNDS PER SQUARE INCH; MAGNIFICATION 120 DIAMETERS

FIG. 4—A SERIES; TENSILE STRENGTH 18,200 POUNDS PER SQUARE INCH; MAGNIFICATION 120 DIAMETERS

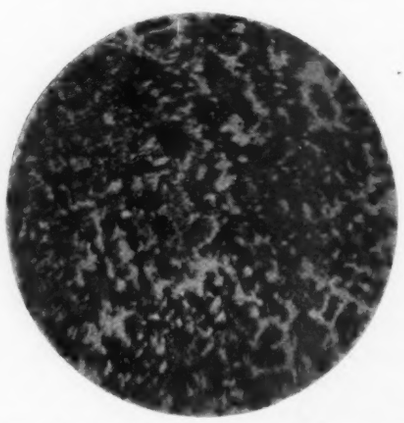


FIG. 5—B SERIES; TENSILE STRENGTH 36,600 POUNDS PER SQUARE INCH; MAGNIFICATION 120 DIAMETERS

rate of cooling was regulated by means of cast iron chills of different thicknesses placed in the molds for three of the bars, the other having no iron chill. The bar without the chill gave a tensile test result of 8.1 tons per square inch, while the bar at the other end of the series broke at 15.2 tons per square inch. These two bars were selected, the chemical analyses of which are given in Table IV.

Chilled and Unchilled Bars.

These results are identical, and as there is practically no combined carbon present, there must be an absence of cementite. The bars are also totally different in chemical composition from those previously examined. Figs. 8 and 9 show unetched sections from the two bars, with the

FIG. 6—A SERIES; TENSILE STRENGTH 18,200 POUNDS PER SQUARE INCH; MAGNIFICATION 30 DIAMETERS

difference in the formation of the graphite as previously pointed out in connection with the other bars, that is, elongated flakes of graphite in the unchilled bar, and finely divided graphite in that of the chilled one. Figs. 10 and 11 show the formation of the phosphorus-eutectic to be in the case of the weak bar broken up and having no distinct pattern, while in the case of a strong bar there is clearly shown that net-like formation which was the distinguishing feature of the strong bar from the B series, but with this difference, that the structure was rather smaller. As there is no cementite present in this specimen, it is proof that the particular formation is not dependent upon cementite.

There was next examined another bar from B series. This had a tensile strength about half way between the two bars previously selected, and had

FIG. 7—B SERIES; TENSILE STRENGTH 36,600 POUNDS PER SQUARE INCH; MAGNIFICATION 30 DIAMETERS

given a tensile test result of 13.9 tons per square inch. The analysis of this bar is shown in Table III. This showed that while the total carbon and other elements were prac-

FIG. 8—UNCHILLED BAR; TENSILE STRENGTH 16,200 POUNDS PER SQUARE INCH; MAGNIFICATION 120 DIAMETERS

tically the same as the two bars previously taken, the graphitic carbon was higher by 0.35 per cent, and the combined carbon lower by 0.35 per cent. This was probably due to the fact that this bar had been cast on a

Table III.

Tensile strength, 13.9 tons per sq. in.	Per cent.
Total carbon	3.272
Graphitic carbon	2.740
Combined carbon	0.532
Silicon	1.307
Sulphur	0.111
Phosphorus	0.948
Manganese	0.330
Iron by difference	94.032

much larger casting than the previous two. The size of the graphite in this bar is illustrated by an unetched section in Fig. 12 which shows, that although it is smaller than that shown in Fig. 2 of the 9.1-ton bar, it is larger and more elongated than that contained in the 18.3-ton bar, Fig. 3. The phosphorus eutectic which is shown in Fig. 13 is the same net-like formation as associated with the previous strong bars, though rather less clearly defined, and appears to be getting into the transition stage between the two. The foregoing results, we think, have been sufficient to show that in each case high physical properties have been associated with this net-like formation of the phosphorus, also that the graphite, when in the elongated form, appears to split up the phosphorus eutectic and prevent this formation as clearly shown in Fig. 6.

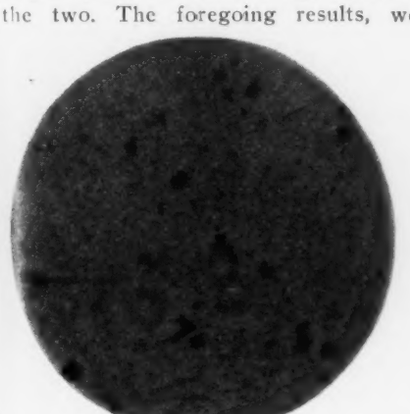


FIG. 9—CHILLED BAR; TENSILE STRENGTH 30,400 POUNDS PER SQUARE INCH; MAGNIFICATION 120 DIAMETERS

The question of the tendency of the graphite to take either an elongated or a finely divided form, we think, is more a question of the way in which the pig iron has been made, than of its subsequent treatment in the foundry. The statement of Mr. Pilkington in this respect is very interesting:

FIG. 10—UNCHILLED BAR; TENSILE STRENGTH 16,200 POUNDS PER SQUARE INCH; MAGNIFICATION 30 DIAMETERS

FIG. 11—CHILLED BAR; TENSILE STRENGTH 30,000 POUNDS PER SQUARE INCH; MAGNIFICATION 120 DIAMETERS.

"Furnacemen have always been conversant with the fact that the temperature at which pig iron leaves the tapping hole of the furnace has a powerful effect on its physical characteristics. The temperature of a large modern blast furnace is very much higher, and the metal therefore takes very much longer to cool than that which leaves the tapping hole of the smaller furnaces. Pig iron from the extreme types could be made practically in a different manner altogether and would show very different grades, grains, and degrees of hardness."

On referring again to the summary of tests taken with the A and B series, it will be seen that the results of the ½-inch transverse bars of the A series, which gave weak tensile

FIG. 12—TENSILE STRENGTH 27,800 POUNDS PER SQUARE INCH; MAGNIFICATION 120 DIAMETERS.

results, are slightly higher than those of the B series, and from this, together with the evidence of the chilled and unchilled bars made from low-grade iron, we are of the opinion that, with ordinary commercial pig irons, no matter what their chemical compositions may be, there is a rate of cooling which will give high physical properties, the structure of the iron

Table IV.

Tensile strength.	Unchilled Bar. 8.1 tons per sq. in. Per cent.	Chilled Bar. 15.2 tons per sq. in. Per cent.
Total carbon	3.284	3.280
Graphitic carbon	3.190	3.190
Combined carbon	0.094	0.090
Silicon	3.366	3.368
Sulphur	0.025	0.026
Phosphorus	1.522	1.524
Manganese	0.231	0.230
Iron by difference	91.572	91.572

then being associated with the net-like formation of the phosphorus eutectic and the cementite, when present.

As the time at our disposal since the commencement of this research has been limited, this short paper is only intended as an introduction to the subject.

FIG. 13—TENSILE STRENGTH 27,800 POUNDS PER SQUARE INCH; MAGNIFICATION 30 DIAMETERS

ECONOMY IN CUPOLA OPERATION*

Comprehensive results of a large number of investigations of methods of melting cast iron --- Discussion of small charges

BY J. W. HENDERSON†

THE mere melting of iron in a cupola is a simple operation. To get the highest efficiency out of raw materials and the necessary equipment, and convert these raw materials into metal most suitable for the work in hand, is another matter. Although not fully realized by foundrymen in general, there is more to the cupola melting of iron and to economic production of castings from cupola metal, than the mere bringing together in a cylindrical stack lined with bricks, certain quantities of fuel and iron at varying temperatures.

Primarily, the engineer is interested in the plant arrangement and equipment and their relation to economic production. As the engineer's work consists in planning the relation of the parts of the foundry to the whole scheme, with a view always to efficiency, he must be interested in all factors that assist or retard this result. In this discussion we are considering factors of economy involved in the conversion of pig iron, scrap, etc., into good castings. Examination of a large number of plants in many states, discovers some of these important factors as follows:

Relation of the receiving track to the ground and building plan. This is important on account of required storage room for raw materials, space for scales and narrow-gage yard tracks, and means for properly handling the charges of fuel and iron.

Weighing facilities that will require careful weighing of each complete charge as a separate unit. This is a sadly neglected part of the equipment in most foundries. A few of the general practices will be mentioned later.

The elevator should be placed, in relation to the position of the cupola, so that the maximum loads of fuel and iron charges can be handled with the least interference with the operations on the charging floor.

The charging room capacity in smaller foundries should be sufficient to carry the charges for the total heat, and in larger foundries adjusted so that the immediate cupola laborers will need the minimum assistance.

Cupola details. Those of importance are:

Extension of the spout into the foundry.

Height of spout above foundry floor.

Depth of cupola from sand bottom to charging door.

Dimensions of charging doors and the distance between the doors and the charging room floor.

Capacity of the cupola, when lined to its largest inside diameter with safety, always in advance of shop requirements, and with blower or fan capacity and adjustment within a range that will permit the melting speed to be as elastic as the needs of the shop might demand.

These engineering details of plant arrangement and equipment not only influence economies, but they also assist or hinder systematic operations and accuracy.

Pioneers in Good Cupola Practice.

Many years' experience convinces that those engaged in chilled iron work, such as cast iron car wheels, and those making malleable iron from the cupola, are to be credited with most of the present development of cupola practice in this country. This has not been on account of their greater intelligence, necessarily, but rather a matter of compulsion. For example, consider car wheel iron. When the metal is running close to the lowest limit as to chilling qualities, if the silicon content increases 0.05 per cent the chill on the wheels will drop below the specification limits, and the wheels made therefrom will be bad so far as their acceptance by the railroads is concerned. If one such wheel among a lot of a hundred, is found by the inspector, he will reject the whole lot even though the other ninety and nine might be known to be all right in every way.

Cupola melting of iron is simple until you give personal attention to the actual running of a cupola and try to produce accurate results as to temperature, composition, chill strength, shrinkage, etc., in any given kind of castings. Some varied experiments may be of interest.

Cupola *A*.—Sand bottom to charging door, 17 feet; diameter straight lining, 45 inches; diameter of melting zone, 38 inches. Cupola started with 1,500 pounds bed coke for 1,500 pounds first iron charge. This was varied to 1,800 pounds bed coke and 2,000 pounds first iron charge, but good, very hot, iron was not obtained under good control until the bed coke was made 2,000 pounds and the first iron charge increased to more than double this or 4,400 pounds. Afterward it was common practice to take out of this cupola at each heat, four different mixtures varying in silicon from 0.75 per cent to 2.50 per cent. Although no extra coke was used to divide them, the four mixtures were produced each day, with the desired differences in composition and separated from each other.

Cupola *B*.—Diameter varied from 48 inches to 69 inches and depth from charging door to sand bottom was 9 feet 6 inches. Weight of pig iron was taken by considering an average weight for the pigs and making up the charges by counting them. Weight of the scrap was left entirely to the guess of the head charger. Charges were supposed to be 4,500 pounds each and were so shown on the records, but on checking up the work being done, and allowing 50 pounds as the average load carried each trip of the men from the scrap pile to the cupola, it was found that the charges would vary from 3,500 pounds to 4,200 pounds. The coke was forked into the cupola until it reached a measured distance from the charging door. At 25 pounds per fork it was found that the total bed coke would amount to 3,400 pounds. After taking up melting on the chemical basis these conditions were changed.

Small Castings.

Cupola *C*.—Making very thin and small special castings requiring very hot iron of uniform composition. Cupola was 50 inches in diameter and 14

*Presented before the Engineers' Society of Western Pennsylvania and published in the July, 1909, Proceedings.

†Foundry Specialist, Gulick, Henderson & Co., Pittsburg.

feet in depth. Coke and iron charged in barrows. At one time they found the average barrow load of coke to weigh 120 pounds, so this was still being used to determine quantities charged. When on hand to check up the actual conditions I was told by the man in charge that the bed coke each day consisted of 1,800 pounds, made up from 15 wheelbarrow loads. Weighing all barrow loads we discovered that the total bed actually weighed 2,600 pounds. Upon this was put the iron charge of 2,500 pounds. Single charges of coke varied throughout the heat from three and one-half to five barrow loads. The product varied in quality with the "luck" which they had in striking the right conditions.

Today this shop is securing very hot iron of uniform quality continuously.

Special Chilled Work.

Cupola *D*.—Making special chilled work. Melting rate was too slow for the enlarged shop; cupola 58-inches in diameter. With single charges of 4,000 pounds each the output was 8.5 tons per hour. Increasing the charges of coke and iron, but reducing the then coke charge gave a melting rate of 9.5 tons per hour. Thus, hotter iron of more uniform composition was obtained, at an increased rate of one ton more per hour. The best results were obtained with the iron charges amounting to 7,000 pounds each. It will be well to say here that the character of the raw materials, the diameter of the cupola, and means for mixing the iron after it is melted, must be considered in determining the size and weight of the iron charges.

Referring again to conditions similar to cupola *B* given above, I will state that where any attempt is made to make up the charges by weight the proceeding is usually somewhat as follows: Scrap, and the iron by brands, are taken up an incline in wheelbarrows, and piled in the charging room. From these the charges are made up piece-meal, on a scale too small to hold a complete charge, and the assembled charge is again piled on the charging room floor. Once more this metal is handled and thrown into the cupola through a door that is above the waist line of the men. Altogether the metal composing the charge is handled five times at least.

The coke is also taken into the charging room by barrows and from the piles thus formed is charged by wire or solid metal basket, or by fork. It is a common thing to find records being kept that show 45 pounds as the basket load when 40 pounds is correct, or vice versa, and 18 pounds to the fork when 25 pounds should be the weight shown.

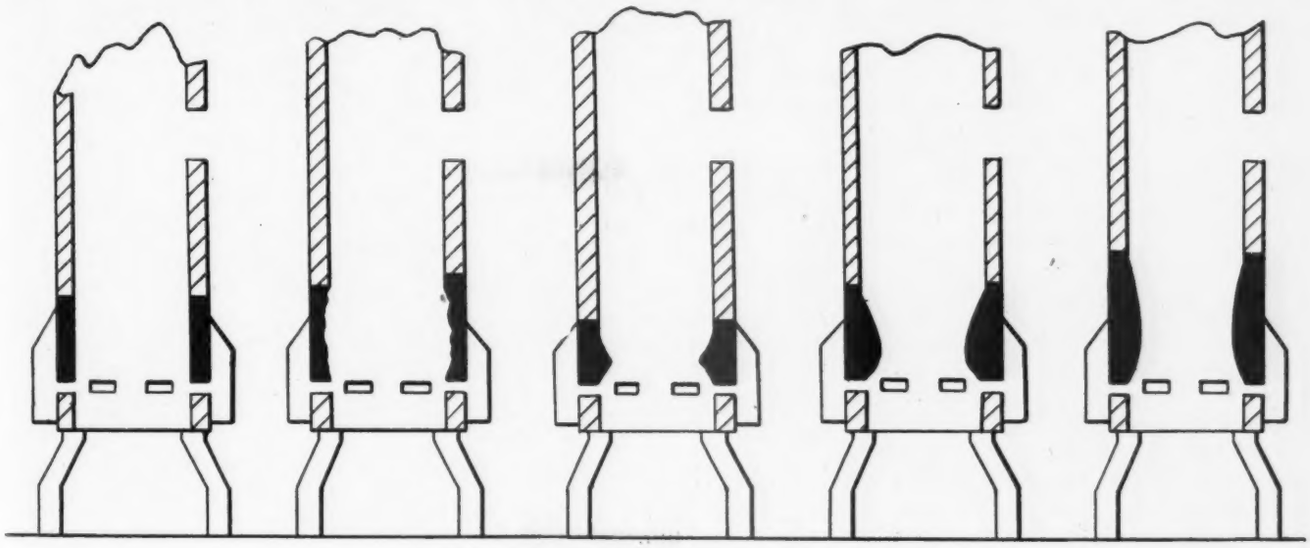
Cupola Linings.

There are five distinct outlines of cupola linings shown in the accompanying illustrations. Eliminating the straight and the burned-out linings as shown in Figs. 1 and 2, if I were asked which of the remaining three is the best, I would not give a direct answer. Each of them is good under certain conditions.

That shown in Fig. 3 will be found the most serviceable, generally. It is quite important where the point of the bulge is placed. If properly used, this bulge will prevent the bunging up of the tuyeres, daily patching of the lining, and will aid the temperature without materially reducing the melting rate.

The arrangement shown in Fig. 4 permits carrying a very thin lining above the bulge. It is also possible with this lining to carry iron bricks in the lining for several rows below the charging door. With this bulge and the thinner lining above it, the cubic capacity can be increased, the quantity of bed coke decreased, while reducing lining repairs and increasing the temperature of the metal. However, with this bulge the charges cannot be melted in their regular order.

The outline shown in Fig. 5 is the best for obtaining uniform temperature, oxidation and melting. The dimensions should be maintained within one-half inch variation each day. This requires patching before each heat. There is no question but that the gain in quality of product is worth the trouble and expense. Only with this style of lining, can accurate melting points be discovered after each heat, that will indicate just how regular the charging has been done. Except for very long heats the melting point can be established by the method of burning the bed coke.



CUPOLA LININGS

FIG. 1 FIG. 2 FIG. 3 FIG. 4 FIG. 5

The Foundry Chemist.

There are, of course, many modifications of the outlines. As a rule, too little attention is paid to the cupola lining and its effect upon temperature and the melting rate.

To accomplish the best results, the mixing by chemical analysis is not merely the province of a chemist. As a matter of fact, where the chemist is only a chemist and not a foundryman, and no one else in the shop is acquainted with chemistry or metal-

lurgy, the chances for definite improvement are doubtful.

This will account for the sad experiences of some few of the foundrymen in this district. There is in mind one proprietor in particular who claims that the entry of a chemist into his foundry cost him $10,000. Where the chemist, who is also an experienced foundryman, has not the co-operation and assistance of the officials and those in direct charge of the cupola and foundry, the results from mixing by chemical analysis will be negative. The chemistry part of it bears about the same relation to the results that the bookkeeping in the establishment bears to the profits at the end of the year.

Again, the chemical analysis of the materials may be perfect, and the weighing of the charges may be accurate, yet the resulting metal from the cupola may be made almost worthless in the operation of melting. Or if these things are carried on as they should be, still the castings may be bad from the way the metal is handled and poured, and in special cases in the manner of cooling or shaking out, or in the annealing of the castings.

Pig Iron Brands.

To the practical chemist and metallurgist the "brands" of iron, as brands, mean nothing except as the name stands for composition and structure. Notwithstanding demonstrated facts which disprove the following claims, it is not an uncommon thing to hear foundrymen express themselves as follows: "Don't the steel go into the sand bottom?" "Don't stove plate go up the stack or out with slag?" "We have to have charcoal iron in our castings in order to get the chill and strength." "Nothing will close up the grain in cylinder castings like old car wheels." And so it goes with the foundrymen visiting conventions, listening to and reading the educational papers, still clinging to the ways of the past century. It does not make any difference what kind of castings you are making, you cannot today get away from the benefits derived from chemistry and metallurgy, and generally better castings at lower cost will be made by employing these in your foundry. Blast furnace practice is not what it was 20 years ago. In those days, if the silicon percentage dropped a given number of points, the chemist, on the particular furnace output, could know that there would be an increase in the sulphur content and almost what the percentage would be. A few years later the same blast furnaces were making low silicon iron containing lower sulphur than was thought possible from coke iron furnaces.

Whether making stove plate or ordinary machine castings, automobile cylinders, semi-steel castings, or any other kind, after once determining the composition and at what temperature the best of these has been made, the desire should be to duplicate them continuously. You cannot be confident of duplicating castings day in and day out, and take advantage of the market changes in iron and fuel, without chemistry and metallurgy.

Variation in Silicon.

Here is the analysis of six pigs taken from the same carload of a well known brand of iron: Silicon, 0.87, 0.99, 1.62, 1.70, 1.79 and 1.82 per cent. Chemistry obtained a rebate on this iron, enabled the foundry to use it without loss of castings and prevented future shipments of such mixed iron from the same source to this foundry. Without chemistry the resulting bad castings would have been charged to the coke first, and if that was found not guilty, then to anything but this particular brand of iron, which had been used theretofore without loss of castings attributable to it.

Analyses of Test Pieces.

FOUNDRY NO. 1.

Test piece.	Silicon, per cent.	Manganese, per cent.	Sulphur, per cent.	Phosphorus, per cent.
No. 1	2.39	0.57	0.088	0.632
No. 2	2.36	0.58	0.076	0.612
Same plant, same kind of castings, one year later.				
No. 1	2.25	0.53	0.074	0.636
No. 2	2.23	0.50	0.064	0.632

FOUNDRY NO. 2.

			Combined carbon.
No. 1	0.55	0.53	0.61
No. 2	0.52	0.57	0.59
No. 3	0.54	0.51	0.60
Same plant, same chilled work several months later.			
No. 1	0.49	0.57	0.60
No. 2	0.55	0.64	0.54
No. 3	0.55	0.49	0.58

FOUNDRY NO. 3.

No. 1	2.54	0.46	0.070	0.720
No. 2	2.44	0.49	0.080	0.690
Same plant, same kind of castings, one year later.				
No. 1	2.42	0.51	0.067	0.778
No. 2	2.32	0.49	0.074	0.780

Knowing these things and that there are frequently even greater variations in analysis between different carloads of the same brand of iron, it is not difficult to realize the lack of uniformity in the castings produced where several hundred carloads of iron are thrown together in one pile. When a number of such piles are found on the property of concerns (generally favorable to scientific methods) the marvel increases.

To be successful, mixing by chemical analysis must be supplementary to that experience which is familiar with general cupola practice and the effect on the results desired, of every operation from the raw materials to the loading of the finished castings for shipment. Given the chemical analysis and applying the personal attention, many foundrymen might work out the results themselves. System in the laboratory has brought the cost of analysis within the reach of even the smallest foundry.

Analyses of Test Pieces.

As indicating what is being accomplished, attention is called to the analyses of test pieces from three plants in different parts of the country, shown in the accompanying table.

While maintaining this uniformity, the castings are being produced at lower mixture cost than before and the casting losses chargeable to the metal are reduced to a minimum. One more point is that of a company which at the beginning of the financial depression, found itself with several hundred tons of iron on hand not suitable for the castings to be made. Business policy dictated buying as little iron as possible at that time and this was accomplished by the chemical analysis indicating just what the minimum amount of iron would have to be composed of to dilute the elements which were too high and what to make up for those elements which were too low, in the stock already on hand.

Advancement.

Advancement in any branch of the iron industry moves in two lines generally parallel to each other, though often converging, the one scientific and the other practical. With cupola melting considered so simple that any man with a few hundred dollars can engage in the business with hope of reward, and with cupola practice in the chaotic condition in which we find it today in even many of the large foundries, advancement in economical melting along either scientific or practical lines needs necessity to give it impetus.

Fundamentally, the small manufacturer cannot take advantage of, and the large one will not introduce, the latest methods affecting economies or a higher standard, worked out by the application of science to practical purposes.

Neither will concede the time to give the application of new methods the personal attention they require and deserve. Foundrymen will run after some new improvement in cupola design, or the suggestions for changes in the size and weight of the iron and fuel charges, when the same amount of time and personal attention given to the devices and materials they now have would yield large returns in econ-

omies to be added to the profits at the end of the year. Ask nine superintendents out of every ten the following questions and see if any of them can promptly answer them correctly:

What are the inside dimensions of your cupola?

What are the inside dimensions of your tuyeres?

What is the actual ratio of coke to iron of the bed charge?

What is the actual ratio of coke to iron of the other charges?

There is in mind a man 75 years of age whose story is a lesson and an example. After stating that he started in the foundry business in 1870, he was asked, "Well, I suppose you have made yourself rich from it in the meantime?" His answer was, "No, I'm poorer than when I began."

We have had combinations in seemingly all lines except that of the gray iron foundry business. It would seem that here is an opportunity on account of the possibilities for economies in all departments, but particularly that of cupola melting. We are never dealing with ultimates. Advancement lies in getting the most of the so-called elements that are in the raw materials at hand in any given locality. Europe has been compelled to be in advance of us in cupola practice. We will find that better malleable can be made in the cupola than has been the experience in the past, and that gray iron in all its branches, including what is called semi-steel, can be produced within definite and somewhat narrow limits as to tensile and transverse strength, chill, wear, deflection, etc. It is an easy matter today to make gray iron with tensile strength 24,000 pounds to 30,000 pounds and semi-steel with tensile strength 36,000 pounds to 42,000 pounds per square inch. There is an unconfirmed report of an eastern concern producing semi-steel with tensile strength in ordinary test bars over 48,000 pounds. The likelihood is that competition, and combinations of capital, and increased cost of raw materials, will do more towards economies in this branch of founding than all the inherent intelligence or present standards for excellence.

Discussion.

In discussing this paper W. A. Bole, consulting engineer of the Westinghouse Machine Co., stated that the European type of cupola is almost invariably built without any reservoir capacity for holding the metal within the cupola. The tuyeres are low, near the bottom. In the style of cupola in vogue in this country, he added that it is bad practice to permit the molten metal to lie in the cupola accumulating until it can be tapped out, very likely taking up a considerable amount of the sulphur content of the coke.

Small Charges.

In reply to a question as to the advisability of using small charges in the cupola as suggested by Dr. Moldenke, J. W. Henderson said that theoretically this may be the proper method, but practically it does not work out. In one instance a cupola was melting too slow for the shop on account of increased capacity; the furnace had a diameter of 58 inches and carried about 4,000-pound charges. These were increased to 7,000 pounds, and instead of multiplying the coke charge proportionaly, it was reduced. Hotter iron was secured, of more uniform quality and the melting was facilitated. He also stated that the melting ratio for stove plate and thin plate work of that kind should average 1 to 8 or 1 to 9, but on car wheel work or ordinary gray iron castings there is no reason why the ratio cannot be reduced to 1 to 10. Mr. Bole also paid a tribute to the Swiss engine builders who do not charge their steel scrap into the cupola for the same heat from which the castings are to be made. The steel scrap is charged into the residual iron the day previous and the mixture is poured into the pig bed. These pigs are then broken up into pieces not over 6 or 8 inches long and remelted. The use of by-product coke was also referred to and it was stated that in Detroit foundrymen are paying a premium for this grade of fuel. It carries from 0.5 to 0.6 per cent of sulphur.

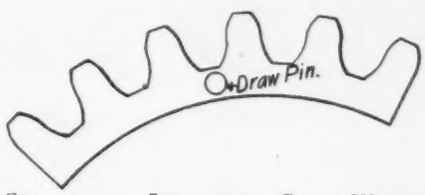
Charcoal Iron.

Referring to the use of charcoal iron in the casting of car wheels, J. W. Henderson said that none of this grade of iron is necessary in the production of these castings. In explanation of his statement, he added: "It does not make any difference where you get the elements from, if you duplicate them under the same heat treatment with all the foundry conditions the same, you get the same results. I have been in the car wheel business a good many years and was at a shop where they had a great many difficulties. They made wheels at one time out of what was considered the very best charcoal iron that could be had, yet most of these castings were very weak and many were broken by one or two blows of the standard test drop. Later, under improved methods, these car wheels were made without charcoal iron and in some cases the wheels would stand 100 to 200 per cent more than required by the specifications, showing that the treatment of the metal as it is being melted, its treatment after being melted, and the treatment of the castings while being poured, and after being poured, are of greater importance than the raw materials."

PATCHING GEAR WHEEL MOLDS

By Pat Mounter

Molding gear wheels on the floor requires considerable skill and is not always productive of accurate work, as sometimes, in patching a broken tooth by placing two extra teeth on either side, the repaired tooth is not true. It is admitted that machine-made gears are more accurate, as the molds are shaken out if any of the teeth are broken down. However, this is by no means necessary in making molds either on the machine or on the floor, and molds that heretofore have had to be shaken out can be accurately repaired by a simple method that I have devised. If one or two teeth are broken down, I make a pattern of a section of the rim containing five or six teeth, with either plaster of Paris or aluminum, and if more than one mold is to be made, this make-shift pattern can be used to excellent advantage in repairing subsequent molds. This pattern is shown in the accompanying illustration and will save considerable time and expense in molding gears, both on the floor and on the machine.



Section of Improvised Gear Wheel Rim Pattern for Repairing a Broken Tooth

TROPENAS STEEL PLANT FOR THE CAVITE NAVY YARD.

The Tropenas Steel Co., New Castle, Del., has been awarded a contract by the United States government for the complete equipment of the converter steel casting plant to be installed at the Cavite navy yard, Philippine Islands. It will consist of a two-ton converter, including electrically-driven blowers and an electrically-operated sand grinder for the preparation of facing sand, cold saw, complete oil equipment, drying ovens, ladles, etc. This equipment is to be delivered before the end of September.

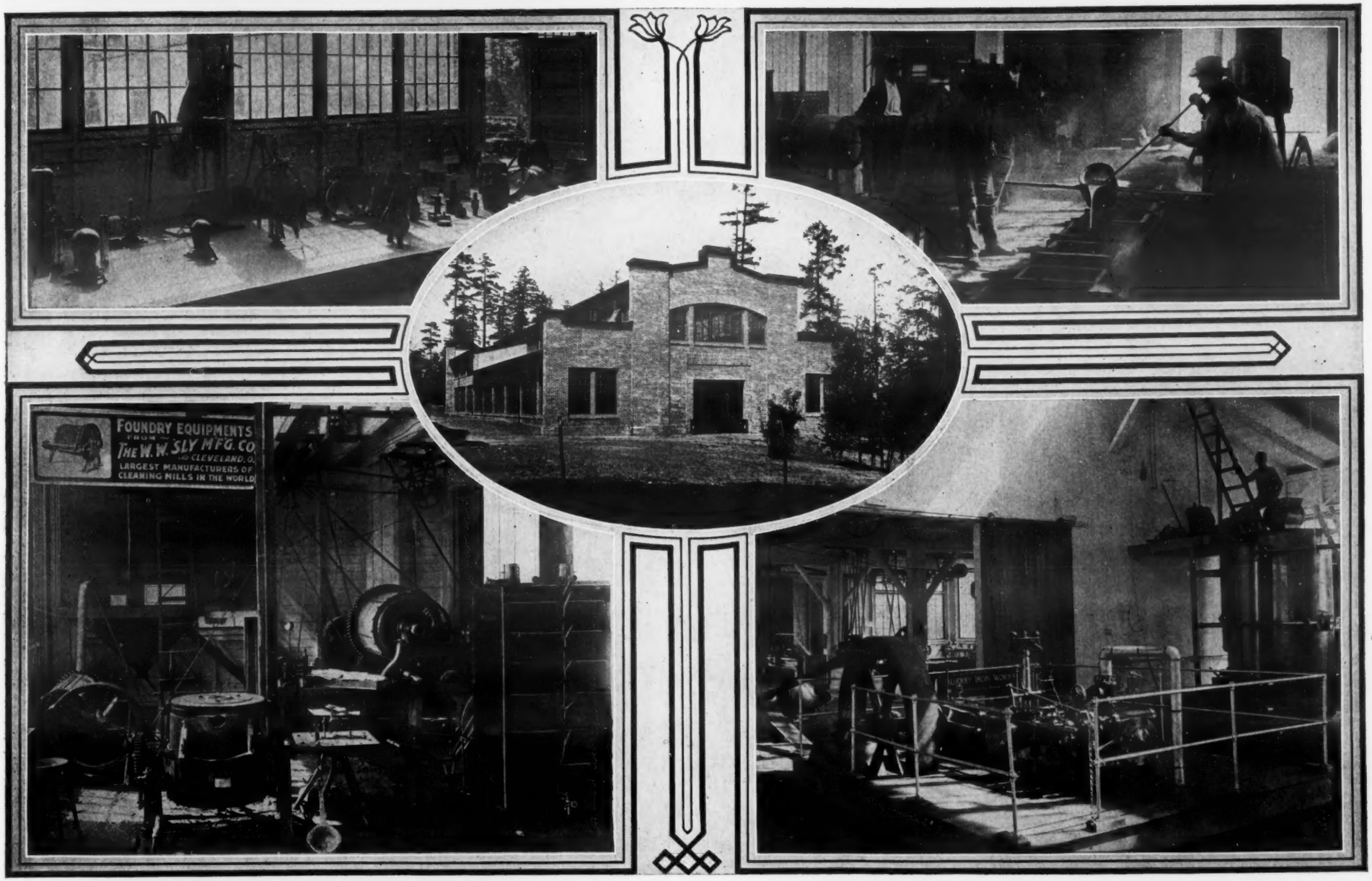


EXHIBIT OF FOUNDRY SUPPLIES AND EQUIPMENT AT THE ALASKA-YUKON-PACIFIC EXPOSITION

EXHIBIT OF FOUNDRY SUPPLIES BY THE E. P. JAMISON CO.

POURING THE FIRST HEAT IN THE MODEL FOUNDRY

THE MODEL FOUNDRY

EXHIBIT OF CINDER MILL AND CLEANING EQUIPMENT BY THE W. W. SLY MFG. CO., CLEVELAND, AND CRUCIBLE TILTING MELTING FURNACES AND CORE OVEN BY THE MORGAN ENGINEERING & MFG. CO., BALTIMORE

CORLISS ENGINE EXHIBITED BY THE MURRAY IRON WORKS, BURLINGTON, IOWA

SEATTLE FOUNDRY EQUIPMENT EXHIBIT

The model foundry at the Alaska-Yukon-Pacific Exposition --- First exhibition of foundry supplies and equipment west of the Mississippi River

BY H. COLE ESTEP

AN EVENT of more than passing interest to the foundry trade was the opening of the model foundry at the Alaska - Yukon - Pacific exposition, Seattle, on Thursday, July 22, on which date the first heat was taken off. This marks the first attempt to hold an exhibition of foundry supplies and equipment at any point west of the Mississippi river. The exposition foundry has something more than a transient claim to interest; it is a permanent structure and after the Fair will become part of the mechanical engineering equipment of the University of Washington. The university will in this way obtain one of the largest and most up-to-date college foundries in the world.

The Building.

The building is a brick and timber structure, 200 x 70 feet. It is of pleasing design and is a good example of a modern foundry building. The windows are unusually large, occupying 90 per cent of the wall space, and the ventilation through the roof is ample. The main doors are large enough to admit a box car. The foundry proper is 70 x 100 feet, the other half of the building being devoted to engine room, exhibits, etc. The central bay, spanned by a 10-ton traveling crane, is 30 feet wide. The crane was built by the mechanical engineering department of the University of Washington.

Location of the Cupola.

A radical departure from standard foundry practice is found in the location of the cupola. Instead of being centrally located with regard to the floor, as usual, it is placed at the south end of the building, so that it can be more readily seen by the spectators while in operation. Aside from this, and the care and thoroughness with which the building was constructed, the exposition foundry does not differ from the average commercial shop.

Exhibits.

The two side bays are used for exhibit space, leaving the central bay free for molding floor. Among the exhibits are the following:

One 26-inch Whiting cupola, Whiting Foundry Equipment Co., Harvey, Ill.

One roll-over and one stripping plate molding machine, Henry E. Pridmore, Chicago.

One Adams squeezer molding machine, Adams Co., Dubuque, Ia.

Sand blast apparatus, Detroit Foundry Supply Co., Detroit.

One cinder mill, dust arrester and tumbling mill, W. W. Sly Mfg. Co., Cleveland.

One oil-burning melting furnace and one oil-fired core oven, Monarch Engineering & Mfg. Co., Baltimore.

Corliss engine, Murray Iron Works, Burlington, Ia.

One pressure gas producer designed

COKE SUPPLIED BY WILKESON - COAL & COKE CO.
E.P. JAMISON & CO.
MOULDING SAND SUPPLIED BY CEDAR MOUNTAIN COAL and COKE CO
FIRE BRICK & CLAY SUPPLIED BY DENNY RENTON CLAY & COAL CO.
HAN YANG PIG IRON
E.P. JAMISON & CO.

GENERAL VIEW OF THE MODEL FOUNDRY AT THE ALASKA-YUKON-PACIFIC EXPOSITION, SEATTLE, WASH.

EXHIBIT OF CINDER MILL AND CLEANING EQUIPMENT BY THE W. W. SLY MFG. CO., CLEVELAND, AND CRUCIBLE TILTING MELTING FURNACES AND CORE OVEN BY THE MONARCH ENGINEERING & MFG. CO., BALTIMORE.

CORLISS ENGINE EXHIBITED BY THE MURRAY IRON WORKS,

for burning bituminous coal, lignites, soft wood and mill refuse, Northern Gas & Power Co., Vancouver, B. C.

The Han Yang Iron & Steel Co., through its distributor, E. P. Jamison & Co., Seattle, is exhibiting several grades of Chinese pig iron. The Wilkinson Coal & Coke Co., local manufacturers of foundry coke; the Cedar Mountain Coal & Coke Co., miners of molding sand, and E. P. Jamison & Co., dealers in foundry supplies and equipment, each have extensive exhibits.

All the machinery is seen in operation. Heats will be taken off once a week throughout the exposition period. The foundry is under the direction of O. E. Eastwood, professor of mechanical engineering, University of Washington.

A PRACTICAL CORE BOX SYSTEM

BY H. N. TUTTLE

IN ANY factory which uses a very large number of cores of small size, and where this number is constantly increasing, the subject of systematizing the core boxes in use becomes of sufficient importance to give to it considerable study. First, of course, is the consideration of the cost of making the cores. For small cores probably no other way is as economical as the use of the multiple iron box and oil sand, or compound, which is rammed by jarring. These boxes are generally made by facing

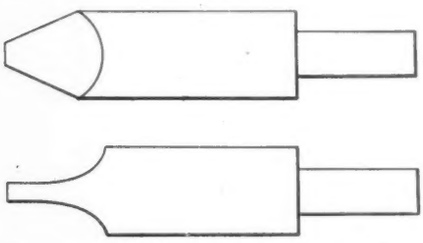


FIG. 1—TOOLS FOR FINISHING CORE BOXES

the blank halves of the box, dowelling together and drilling. The first drilling operation is generally made with a small drill, say 5/16-inch, with a piece of paste-board between the halves of box to insure the drill following the parting. The paste-board is then removed and drilling is continued with larger drills, finishing with a flat taper reamer, Fig. 1, which should be allowed to cut about 1/16-inch stock the entire length of the box, and which leaves the proper-shaped cope print at the bottom end of the box. This print is generally made about 14 degrees taper, but, at any rate, it should be made some standard angle or dimensions, so that all patterns will have like cope prints for like diameters of cores. These drilled boxes are usually made up to 1¼ inches in diameter, and in such lengths as will permit the cores to stand on end without sagging. The cores are spaced so as to get as many as possible in some standard width of box, say 8 inches wide, so that all boxes will nicely fill up the standard width dryer plate.

When equipped for making these multiple boxes, it requires only from two to four hours to produce them, so that they are comparatively inexpensive considering their great advantage over a single box. But when there are a great many of these small cores of all sizes and lengths to be made, and these are continually being added to, the making of the boxes comes to be quite an item and, what is more important, the keeping track of the boxes and cores.

Simple Core Box Record.

When the variation is only slight, many mistakes are made by the molder setting cores a little too short or a little long, thereby perhaps throwing the cored hole out of true or crushing in the cope. In a factory where these conditions prevailed the following system was worked out, with the main idea of having a system which would make it convenient for the patternmaker, coremaker, and molder to keep track of the cores and boxes.

First, it will be noted that this style of core requires what molders call a "straight drag print," that is, there is no taper to the drag end of the core. Of course, there will be a slight draft on the print of the pattern, so that it will draw nicely. In Fig. 2 the diameter of the print midway of its length, at A, is made equal to the diameter of the core. At the outer end B it is made about 1/100-inch smaller, and at C, 1/100-inch larger than the diameter of the core. If the corner, B, is slightly rounded, it will leave the sand better, and will cause no inconvenience in setting the core. It will be noted that with this style of print its exact length is immaterial, that is, if it be ⅛-inch longer or shorter than a reasonable standard length, it would make no difference as long as the distance from B to E in the pattern is exactly equal to the length of the core. All boxes, then, are made to lengths varying by ¼-inch. Thus, if one box be 2 inches long, the next length of the same diameter would be 2¼ inches, but there would be no box 2 1/16 inches, 2⅛ inches, or 2 3/16 inches long. This difference would be made up by varying the length of the drag print or the pattern. In this system, in speaking of the length of a core or core box, it is much more convenient to consider the length of the straight part of the core only, and as the cope prints are standard and therefore all alike, if of the same diameter, there will be no objection to doing so. The inconvenience of giving the entire length of the box is due to the fact that the cope prints will not come out in exact quarters in length.

Numbering the Core Boxes.

The boxes are made to vary in diameter by 1/16-inch, and as they vary in length by ¼-inch, they may be easily numbered accordingly, and, by

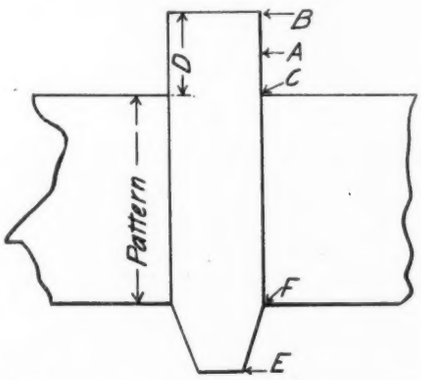


FIG. 2—CORE WITH STRAIGHT DRAG PRINT

always placing the diameter first, the fractional style of number may be reduced to a plain number. Thus, a core 13/16-inch in diameter, and 2¼ inches long would be No. 139, that is, 13/16-inch in diameter and 9/4 inches long. So, also, a core 9/16-inch diameter and 3¼ inches long would be No. 913, or a core 1 3/16 inches diameter 4¾ inches long would be 1919. As the range of diameters and lengths is so small, this system could cause no misunderstanding. By stamping the number on the core boxes and on the bins wherein the cores are stored, they may easily be numerically arranged according to their diameters

and lengths. Then, by also having the number stamped on the core prints of all patterns, the molder can go to the proper bin and get his cores without confusion and without waiting for the coremaker to find them for him. There may be dozens of patterns in use which require the same core, but the coremaker need pay no attention to this, nor even know anything about it. All he has to do is to keep his bins reasonably well filled with cores. When the patternmaker is making a new pattern, all he has to do is to place his rule upon his lay-out, or drawing measuring from F, Fig. 2, and see what would be the best length to use and make his drag print accordingly. He then stamps the number of the box upon the drag print.

The range of an entire set of these boxes would vary considerably in different factories and it would probably not be advisable to try to make a complete set at once; however, a list of the boxes made could be kept in the pattern shop and new ones made when necessary. Old boxes already made can be easily shortened to some other length by planing off the drag end, so that if there are a large number of boxes on hand, the expense of systematizing would not be very great.

Boxes for cores which are set horizontal, and therefore do not need the taper print, may, of course, be systematized the same way, perhaps adding an S after the number to indicate a straight core. A variation of ½-inch in length would be satisfactory for straight cores, as the prints may be varied on either end. The systematizing of pocket cores has not been attempted, as there are too many dimensions which cannot be changed to make it feasible.

THE APPLICATION OF RULE OF THUMB METHODS AND SCIENCE IN FOUNDRY WORK*

BY SYDNEY G. SMITH

FROM a foundryman's point of view it is regrettable that the importance of design is so little understood by technical men in relation to iron castings, because bad designs involve internal stresses which arise from unequal contraction and cooling, and affects the law of crystallization in solidification, causing spongy, unsound, weak castings. As far as possible the thickness should be uniform, apart from solid bodies and where divisions are made by means of cores. The writer contends that to make a sound casting of the jacketed type, there should be little or no difference in the thickness of the metal of both walls for the reason that when there is a thin and thick section there will be a difference in the rate of cooling, also unequal contraction. This is undesirable at any time, but more especially in a complicated and costly casting. The outside wall, which should be thinnest, will solidify first, and as it cools its tendency is to draw and pull and rob the thicker and working section of its density and soundness. For similar reasons many examples of faulty design may be enumerated, such as thick flanges, heavy sockets on a thin body, irregularities in stanchions, columns, pulleys, and gear wheels, etc., which present difficulties for the foundry.

The question as to how a casting should be made, whether in sand or loam, depends upon its shape, size, and the number required. When the number ordered does not warrant the expense of making a pattern, it is often more economical to make the casting in loam, although it may be possible in this instance to make two castings in sand if a pattern is made, in the same time as one in loam, but of course the saving is in the pattern shop.

Molding Sand.

In selecting sand for facing, of which there are three or more strengths, varying chiefly in alumina, thickness of metal and depth of casting must be considered. Although a good blacking will resist the bite of the metal, when thick, deep castings are made, a sand sufficiently strong in alumina must back it up to prevent fusion with the fusible silicates in the sand. An experienced molder can tell by the "feel" of the different sands which is the most suitable for the work in hand. The analysis of the sand, in most instances, would be of no possible value whatever to him, nor does the writer think it possible for a tabulated form of analyses to be of practical value for all kinds and classes of work. Very roughly, this may be done, but with a casting of great thickness and depth the sand need not be as strong near the top half of the mold as in the bottom half. This also applies to any casting having a great depth. I am not trying to make analysis impossible, but endeavoring to show that in this case it is impracticable, and more or less "rule of thumb" must prevail. Light work requires a sand low in alumina; heavy work requires a sand containing a higher percentage of alumina; for very heavy work there should be a still greater percentage of alumina. If I were asked to tabulate a form of analyses of sands for different thicknesses of iron, approximately it would be as follows:

For castings averaging 1 inch in thickness, "weak" sand containing 6 per cent of alumina.

For castings averaging 2 inches in thickness, "medium" sand containing 8 per cent of alumina.

For castings over 3 inches in thickness, "strong" sand containing 10 per cent alumina.

Facings.

I wish to enlarge a little upon the use and misuse of coal dust. If a casting is made in green sand we add coal dust to the facing, but if made in dry sand or loam we do not, or should not, because in the two latter cases we wash with blacking. Coal dust should only be added when the mold is green sand, or skin dried; if it is added to dry sand work it is simply wasted, is of no service, and does more harm than good, as it increases gases of which there are already plenty in the mold to contend with. The coal dust is mixed with the facing sand, so that the sand will strip and leave a smooth, clean skin on the casting. It does this by burning when in contact with the molten iron, creating a gas and forming a film which prevents the iron from fusing the silicates. The amount of coal dust required in mixtures of facing depends chiefly upon the thickness of

*Presented at the Birmingham, England, convention of the British Foundrymen's Association.

the casting, and temperature of the iron when poured, and again, in this instance, "rule of thumb" experience must prevail, as it would not be practical to work to a formula owing to the many varying conditions. In practice we roughly work to measures of coal dust per bulk of sand, which may be often altered to suit the work required. In many instances it is unwise to have the same amount of coal dust on the top part of a casting as the other parts, so that if we had a formula for different thicknesses of iron it is obvious it could not be a fixed one.

Iron Mixtures.

In recent papers on foundry work I referred to mixing iron for different classes of work by analysis, fracture and physical tests. I do not propose to enlarge upon this subject to any great length, but contend that it is unreliable to depend absolutely upon either of these alone. These three factors, so to speak, should be weighed together, and to depend upon either of these alone may be deceptive. It is admitted that it is not easy to get certain uniform results from the same analysis or fracture, and our position so far upon this matter is not a very clear one. The vital point is that the casting shall be of a mixture that will stand the stress, wear and tear, and meet its demands satisfactorily, and the foundryman who accomplishes this, no matter by what means, whether by judgment, fracture, analysis, mixture of different grades and brands of iron, or the addition of alloys, has done everything possible to insure sound castings.

Influence of Metalloids.

Carbon in its two forms is the important determining element of weakness and strength, and is influenced by the content percentages of the other metalloids regarding its form and action. Combined carbon increases shrinkage and chill, imparts softness and shows a closer grain. Graphitic carbon shows an open grain, reduces shrinkage and chill, and indirectly softens the iron. Generally speaking, most grades of iron, from hard to soft, vary in the percentage of the combined and graphitic carbon. Silicon has a tendency to change the combined carbon into the graphitic form, thus resulting in a soft iron.

Phosphorus gives fluidity, favors clean iron, and is said to reduce shrinkage. With high silicon a fluid iron will be produced, but it has little strength.

Sulphur has a strong affinity for iron, it hardens and increases shrinkage and chill by a powerful influence upon the carbon, changing it to the combined form.

Manganese is brittle and hard. Its influence upon the carbon is to assume the combined state, hence it increases the chill, stiffens the iron, and consequently reduces deflection; it partially eliminates sulphur and is considered to give the best results when its content is under 1 per cent.

Silicon Control.

Much has been written on the subject of silicon control, the percentage of which is lowered as the castings increase in thickness. It is generally understood that for thin castings, the silicon content should be high to give the desired softness, and to produce closeness and stiffness in thick castings the silicon should be low. For ordinary work the following tabulated and standardized system is good and well worth considering, and has been used more or less in our calculations for some years past:

For castings under ⅝ inch thick, the silicon content desired is 2.55 per cent.
For castings averaging ⅞ inch, for machine parts, the silicon content desired is 2.40 per cent.
For castings from 1¼ inches to 2 inches thick, the silicon content desired is 2.25 per cent.
In each case the combined carbon is 0.40 per cent, graphitic carbon 3.10 per cent, manganese 0.40 per cent; phosphorus decreases from 0.90 per cent in the thinnest to 0.60 per cent in the thickest section; sulphur increases from 0.08 per cent in the thinnest to 0.10 per cent in the thickest section; sulphur increases and phosphorus decreases as the silicon content is reduced.

Although we may not agree as to the large percentage of silicon content, it appears to the writer to be a foundation stone to a groundwork for a system of standardization by analysis, and I understand that this system is past its experimental stage and is actually in operation at the works of Ludw. Lowe & Co., Ltd.

I do not for a moment think that the behavior of the different contents would be uniform under all circumstances. By that I mean with results of mechanical tests and fracture. If it were so I should be very much surprised, as we have not yet discovered why analyses and physical tests are not in absolute agreement. However, it appears to the writer that silicon is the most convenient form of control. Personally I wish iron contained no silicon and that we had something better to control the carbons. Although its presence softens, it is only by its influence in increasing graphitic carbon that it breaks the continuity of the matrix.

Cupola Practice.

In melting iron in a cupola there are many varying conditions to contend with, such as pressure of blast, quality and quantity of coke and flux, method of charging and amount of the same. The writer has heard the cupola referred to as "a thing of mystery," but does not know why it should be so considered. I believe that the cupola does not receive the attention it should, and am of the opinion that large sums of money may be lost owing to lack of proper attention. This is a phase of foundry work that lends itself to scientific control. An insufficient amount or an excess of coke, flux or blast is a dead loss, and results in either a sluggish, dirty iron, or an iron that has been deprived of its silicon, is high in sulphur, and consequently hard. In addition to this, the unnecessary wear around the melting zone and tuyeres show bad melting and waste or want of coke, flux or blast.

I give particulars of a cupola which is daily in blast and which I consider is fairly economical:

Diameter of shell, 8 feet.
Diameter of lining, 6 feet.
Distance from bottom to tuyeres, 36 inches.
Distance from bottom to slagging hole, 24 inches.
Diameter of blast main, 24 inches.
Number of tuyeres, 7.
Size of tuyeres, 9 x 4 inches (semi-circular ends).
Area of fan outlets equal to 24 inches.
Revolutions of fan, 1,000 per minute.
Diameter of fan casing, 5 feet x 12 inches wide, driven direct by a 30-horsepower motor.
Blast pressure, 8 ounces by mercury gage.
Weight per charge of iron, 1 ton.
Limestone, 28 pounds per charge.
Coke, 1½ hundredweights per charge.
Melts 100 tons per day.
Self-charged by means of lift and chute.
Total cost of labor, 5 pence per ton.

I do not favor too low a consumption of coke or flux. Therein lies as much danger of loss as the other extreme. Some may congratulate themselves upon the low percentage of coke used per ton of iron, but it may be a revelation if the slag were occasionally analyzed. I am inclined to think it would contain more than 5 per cent of ferrous oxide, besides the upper parts of castings made with iron melted with a low or poor coke will not be sound.

One matter must not be overlooked. Very seldom do two cupolas work exactly alike and give similar results. I know of two cupolas which stand side by side, are the same in measurement and identical in tuyere arrangement, area, etc., and yet one of them will give better results with less blast than the other. A capable cupola man will study his cupola and obtain reasonable control.

I agree that there is something to

be said in favor of Richard Moldenke's contention that smaller charges are advantageous. Perhaps all the evils he mentions will not disappear, but there is reason to believe they will be minimized.

The writer is of the opinion that 20 cwts. charges of iron are large enough for cupolas up to 60 inches diameter; that 1¼ cwts. of good coke per ton of ordinary iron are not too much; that 25 pounds of good limestone are sufficient per ton of iron; that 8½ ounces of blast, as shown by a mercury gage, is strong enough for cupolas up to the diameter just named; that one row of tuyeres is better than two; that a few large tuyeres are better than many small ones.

Feeding Castings.

There are few things more important than the judicious use of the feed rod. For some reason molders are not in love with the feed rod, and seem to regard it as a superfluous operation, quite unnecessary when the mold is full of iron. This peculiarity is more pronounced when the weather is very hot. However, feeding is important, and where there are heavy and irregular bodies, judgment and care are necessary, as the operation is purely "rule of thumb." If the casting is cylindrical and vertically cast the feed head should never be less than the section of the casting. The depth of the head should be according to the length and general thickness of the casting and will feed sounder if larger at the top than at the root. No hard and fast dimensions can be given for a feeding head.

There are many other phases of foundry work that may be referred to. I have simply touched on the fringe of a few, and sum up the main features in the following order:

That "rule of thumb" methods, born of experience, still hold good in many of the operations of daily foundry work.

That design of castings is a matter that should receive more attention.

That foundry and pattern shop foremen should work in conjunction.

That the manipulations in mixing iron are important and there is ample room for the assistance of the chemist, metallurgist and the man of experience.

That cupola practice is worthy of the attention of those concerned in the management of the foundry.

That the practical man should not ignore the technical man, but acquire from him all that he can apply to his trade.

That to obtain the best results in the foundry the practical, technical and scientific men should work hand in hand.

ANALYSIS OF THE LAST PART OF A BASIC OPEN-HEARTH HEAT

BY R. A. BULL

A PRODUCER of steel castings some time ago was painfully surprised by the service failure of certain castings that were designed with an ample factor of safety, and that had been made under painstaking shop conditions. The first of these defective castings was followed by several others, the analyses of drillings from all of them being found abnormal. The service the castings had been called upon to do was most severe, and their failure to perform it a serious matter. It was noted that all of these returned castings were such as are always poured from the last part of the heat, they being relatively small in size, compared with the general run of work in this particular plant. The ladleman kept tab, so to speak, on the tonnage he had poured, by the assistance of a clerk, and reserved his smallest molds for the last of the metal, to avoid slagging on a larger, more expensive mold. From these premises, it was no new discovery that the steel poured last in basic practice is of inferior quality, for that has been of common knowledge among all steel makers for many years. But the important fact demonstrated was, just to what degree this deterioration takes place. A series of analyses was made from a number of heats, all made as nearly as possible under identical conditions. The accompanying table gives the results of seven such, this being a typical selection, and large enough to illustrate the fluctuations.

The results given in this table are not entirely complete in the information they impart without the following statements: First, that the melting stock was strictly high grade, the pig being low phosphorus and low sulphur basic and the scrap being about equally divided between foundry scrap (gates, risers, defective castings, etc.) and rails, springs and structural shapes.

Second, that the fuel was crude oil, and free from any such contamination as often occurs with the use of producer gas, made from poor coal.

The writer has grounds for claiming that this deterioration has not been given the attention it should receive at the hands of basic steel founders or their customers. He believes that the present practice followed in a few plants within his knowledge, of scrapping the latter 2 to 3 per cent of the metal, and not pouring into salable castings, is the only safe method of giving the purchaser what he should have, if the castings are to be subjected to shocks or strains. And he further believes that the consumer should have some advice on this subject, so that he may so far as practicable throw proper safeguards around the manufacture of steel castings, made on a basic hearth, of which much may be expected.

Analysis of Basic Steel.

The analysis of basic steel should receive more attention, as to maximum phosphorus and sulphur, than that of acid steel, for several reasons. The acid process being practically not much more than a melting manipulation, the manufacturer is compelled to buy melting stock, both pig and scrap, of low phosphorus and sulphur content, for in the acid furnace he cannot reduce these elements. But the basic founder has abundant latitude in this respect, and buys any sort of raw material he wishes, for he can reduce the objectionable metalloids after his heat is melted, his process being a refining one, and his regular heat test (usually taken about the middle of the heat) will analyze below the stipulated maximum.

Because of the latter fact, he is tempted to buy and often conscientiously does buy, pig iron that runs very high, say in phosphorus, for he can of course secure such stock at a relatively low figure. The additional limerock required—the usual dephosphorizer—is a small item, for this is a cheap commodity in itself, although

the steel founder might be surprised if he could actually determine to what extent this additional lime will reduce the life of his furnace. Preliminary analyses of heats made rrom such pig iron will show high phosphorus, which the melter will "work down" to normal, only, as he may imagine, at the expense of a little more time in making his heat, and the cost of additional lime-rock. The phosphorus is not destroyed but heavily impregnates the slag above the metal. During the teeming process the suction produced by the flow through the nozzle adds to the natural gravitation of the phosphorus, which descending to the lower line of slag is partially taken up by the upper portion of the steel. The result is that the last metal poured prior to slagging is heavily charged with an impurity that is relatively small in the balance of the castings.

AFTER POURING	P	S	MN	SI	MINIMA AND MAXIMA PHOSPHORUS	SULPHUR	MANGANESE	SILICON
50 %	.018	.020	.79	.34	1 2 3 4 5	2 3 4	5 6 7 8 9	2 3 4
89 "	.024	.020	.75	.30				
93 "	.027	.023	.74	.32				
96 "	.026	.023	.73	.31				
100 "	.031	.021	.73	.25				
50 "	.018	.021	.82	.32	1 2 3 4 5	2 3 4	5 6 7 8 9	2 3 4
89 "	.029	.024	.75	.26				
93 "	.032	.024	.72	.26				
96 "	.036	.024	.71	.26				
100 "	.038	.027	.68	.24				
50 "	.018	.018	.81	.38	1 2 3 4 5	2 3 4	5 6 7 8 9	2 3 4
89 "	.024	.019	.72	.34				
93 "	.024	.020	.68	.33				
96 "	.026	.022	.66	.32				
100 "	.031	.023	.58	.30				
50 "	.028	.026	.82	.35	1 2 3 4 5	2 3 4	5 6 7 8 9	2 3 4
89 "	.037	.028	.79	.33				
93 "	.039	.028	.77	.31				
96 "	.039	.028	.75	.31				
100 "	.056	.029	.71	.21				
50 "	.024	.025	.70	.25	1 2 3 4 5	2 3 4	5 6 7 8 9	2 3 4
89 "	.035	.029	.63	.22				
93 "	.038	.029	.61	.21				
96 "	.042	.029	.59	.22				
100 "	.046	.032	.57	.21				
50 "	.015	.025	.78	.29	1 2 3 4 5	2 3 4	5 6 7 8 9	2 3 4
89 "	.020	.026	.76	.24				
100 "	.022	.027	.73	.22				
50 "	.023	.026	.73	.33	1 2 3 4 5	2 3 4	5 6 7 8 9	2 3 4
89 "	.034	.027	.71	.29				
100 "	.044	.032	.70	.23				

PROGRESSIVE ANALYSES OF A 50-TON BASIC OPEN-HEARTH HEAT

Note.—In "Minima and Maxima" figures for phosphorus and sulphur show hundredths per cent; figures for manganese and silicon show tenths per cent; the carbons remaining constant throughout are not shown.

Acid and Basic Steel.

This is no doubt one reason why it has been, as the writer believes, too broadly stated by some very conscientious observers, that acid steel is superior to basic steel. It will be seen not only that the phosphorus increases, but that the silicon and manganese decrease during this last transformative period of pouring. Naturally, therefore, these latterly poured castings will contain blow holes. It would be strange indeed if castings of such pronounced inherent unsoundness and reduced homogeneity were to prove satisfactory under conditions of extreme stress. But it is rather a severe stricture on basic steel to give it a second class rating because the latter 3 per cent of the product of this type of hearth is of inferior quality, while the other 97 per cent may be of a high degree of purity—considerably higher than can be attained by the acid process except at commercially prohibitive prices for raw materials. It follows then, that basic steel founders should discard the last part of the heat or pour from it unimportant castings such as flash bars, clamps and the like, and that when the majority of them have adopted this practice less service failures will be charged against them by those who have opportunity of comparing the efficiency of acid and basic castings. It is equally logical that consumers whose requirements of steel castings are severe, in the way of strains and stresses, could not be censured for stipulating in their specifications that such castings shall not be poured just previous to the coming of the slag. It may be pointed out that deterioration is not pronounced in some of the heats reported in the table. But since it is undoubtedly apparent in most of them, notwithstanding the furnace practice and melting stock were in all cases as nearly identical as working conditions permit, it is clear that the producer and the consumer can "play safe" only by condemning what may be likely to prove defective.

A NEW METHOD OF PLATING ALUMINUM.

In a recent issue of the London *Electrical Review* a method for electroplating is described. The author, E. C. Szarvasy, states that up to this time the problem of electroplating aluminum with copper, silver, tin or other metals has not been satisfactorily solved.

The method used is to dissolve a dry salt of the metal to be deposited in methyl alcohol (wood alcohol). Unless the salt is dry, water is introduced which interferes with the success of the operation. The aluminum to be plated is cleaned by polishing or cutting down materials containing grease. When polished or scoured by such material a film of grease is left on the surface. This is not removed, however, as it serves to protect the surface from oxidation. The aluminum is immersed in the solution with the grease on it and the alcohol dissolves it, leaving a clean surface for the deposition of the metal. The deposition is carried on as usual. In copper or nickel plating aluminum, the chloride or other soluble salt is used, but the moisture must previously be removed from it before dissolving in the alcohol.

LARGE CAST STEEL ROLLS.

The Aktiengesellschaft Grusonwerk, Magdeburg-Buckau, Germany, recently supplied a large brass and copper rolling mill with chilled rolls, 44 inches in diameter, having a working surface of 165 inches in length of barrel and weighing 72,500 pounds each. These rolls are slightly larger than the chilled roll cast by the Otis Steel Co., Ltd., Cleveland, which was 42 inches in diameter, 152 inches long, and weighed 71,000 pounds.

The F. E. Arthur Co., 641 Capitol avenue, Hartford, Conn., has been organized to engage in the manufacture of brass ingot metals for the brass foundry trade. F. E. Arthur was formerly connected with the firm of Arthur Bros., East Hampton, Conn., and Suisman & Blumenthal, metal dealers, Hartford, Conn., are interested in this new enterprise.

A NOVEL BASEMENT STORAGE SYSTEM

Description of recent additions made to the plant of the Mesta Machine Co., including a pattern shop and foundry

IN WEST Homestead, on the Monongahela river, about six miles from the business center of Pittsburg, and adjoining the town of Homestead, is located the large plant of the Mesta Machine Co. Being in the heart of the largest iron and steel producing district in the world, its product consists largely of equipment for these works, and includes heavy duty engines for rolling mills, blast furnaces and power plants; rolling mill machinery, steel, sand, and chilled rolls; steel castings, machine molded gears, etc.

The plant covers about 20 acres and has about 500,000 square feet of floor space under roof, more than 400,000 square feet being commanded by electric traveling cranes. Among the more recent additions are a foundry, pattern shop, and pattern storage, and the ground plan, showing their general arrangement, is illustrated in Fig. 1.

Pattern Shop.

The pattern shop, 60 x 165 feet, two stories and basement, extends all across the end of the foundry proper, which is in three bays, 60 feet, 80 feet, and 25 feet wide, respectively. The foundry building is being constructed 1,000 feet in length, of which 300 is now under roof and in service and the remainder is being pushed to completion. The grading and foundation work is completed and erection will follow as rapidly as possible. The pattern storage building is also being extended symmetrically with the foundry.

The pattern shop is interesting and attracts attention, first, because of its appearance of permanency. It has been built as nearly fireproof as engineering skill can design. Heavy steel construction has been imbedded in solid concrete, forming a building practically indestructible. The value of abundant light has been kept in view and, in addition to the continuous row of large windows around three sides of this room, a large skylight extends the entire length of the building. It is very important in building large patterns to have overhead light in addition to the side light, although on the second floor

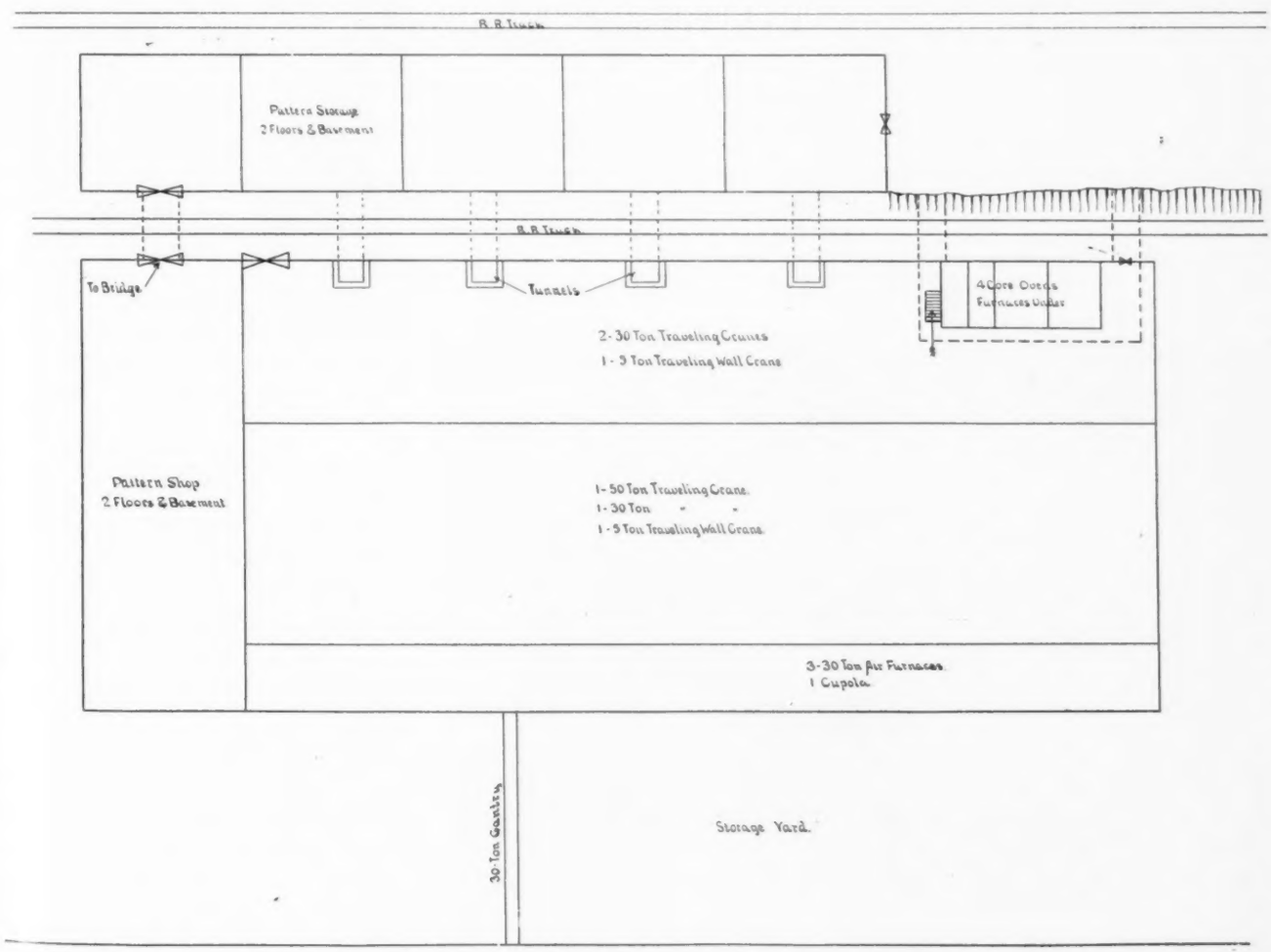


FIG. 1—GROUND PLAN OF FOUNDRY AND PATTERN STORAGE

FIG. 2—BASEMENT OF PATTERN SHOP

the largest pattern can be handled with ease to and from the foundry by overhead electric cranes.

Views in the pattern shop were given in THE FOUNDRY in August, 1909, in connection with a description of its electrical equipment.

The Basement Feature.

A 14-foot basement underlies the entire pattern shop, with solid reinforced concrete side walls, floors and columns. Referring to Fig. 2, which is from the end nearest the pattern storage building, a screen partition will be seen extending across the basement. The space beyond this screen and which is nearly the entire basement, is devoted to merchandise and supplies storage under the care of a storekeeper. These include all supplies in quantity, and which are issued either direct or to the smaller tool and store rooms throughout the works, spare parts, etc. The height of basement floors above the river gives perfect drainage and there is no evidence of the slightest dampness. A large tunnel leads from this basement to the power house, and in this tunnel are carried all the air, steam, gas, and water service lines, and the electric cables, so that nothing is buried underground nor exposed to weather overhead. From the basement also leads a wide tunnel under the railroad tracks to the basement of the pattern storage building. This basement also is the full size of the building and 14 feet high, and is divided into rooms 60 feet long and the full width of the building (50 feet), with doors between. The entire building, including basement floor and the roof, is of reinforced concrete, and the dividing walls extend from basement floor up to the roof. At the ground and upper floors the openings are closed by fire doors. Heavy patterns are stored on the ground floor and shelf patterns on the upper floor.

It is in the basement, however, that interest centers. It will be observed that a railroad track serves each side of the building, and directly from the cars on either track, sands, loam, charcoal, clay, fire brick, etc., can be unloaded into any room of the basement.

From each room a tunnel, about 8 feet wide and 8 feet high, leads under the track to the foundry, terminating in a shaft opening to the foundry floor. Wheeled truck boxes convey supplies to the foot of these shafts, whence they are easily and quickly lifted and transported by the overhead cranes to any point on the floor.

Fig. 3 shows a view in this basement looking through the rooms in series, while to the right will be seen one of the tunnels leading to the foundry. The whole series of rooms is well lighted and ventilated and is apparently perfectly dry.

The Advantages of Basement Storage.

The storage of all materials in a dry, frost-proof location will not only appeal to foundrymen, but the elimination of unsightly sheds, with their mussy surroundings, the convenience with which material may be got to the floor without interfering with floor work and without opening doors in winter time or bad weather, the absolute prevention of the waste invariably attendant upon the usual methods, and the utilization of space otherwise lost, combine to make the scheme noteworthy. The arrangement of core oven furnaces is a further development of the same idea. The established grade line is about 14 feet above the level on which the pattern storage building stands, as is indicated by the fill in Fig. 1.

Therefore, the basement idea is extended to include the core oven furnaces and the tunnels leading from the furnace room will open into succeeding basement rooms in the pattern storage when these are completed.

Fig. 5 shows the furnace fronts, which are only the length of grate from the outside wall. The space in front of the furnaces is utilized for storing small cores, which keeps them

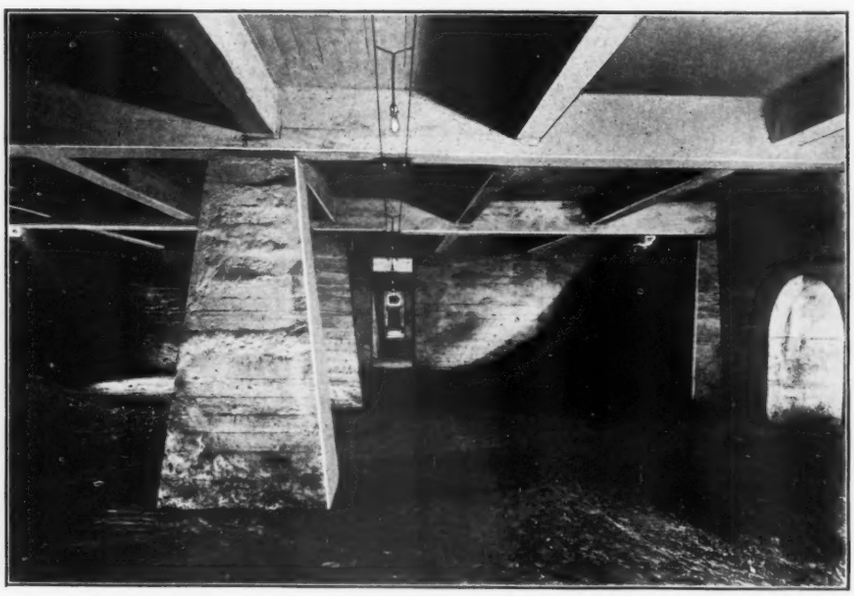


FIG. 3—VIEW IN BASEMENT OF PATTERN STORAGE, SHOWING ROOMS IN SERIES AND TUNNEL TO FOUNDRY

warm and dry and in perfect condition. There is thus no firing at floor level and no handling of coke, ashes, etc., where it interferes with other work. Neatness is characteristic of the entire arrangement, an object generally impossible of attainment in the ordinary layout.

The Foundry.

The foundry itself is of steel, with reinforced concrete roofs. The 60-foot bay is served by two 30-ton travelers and one five-ton traveling wall crane with a 20-foot reach. The 80-foot center floor is served by one 50-ton and one 30-ton traveler, and one five-ton wall traveler, also with 20-foot reach, and numerous jib and air cranes are also provided. As the lengthening of

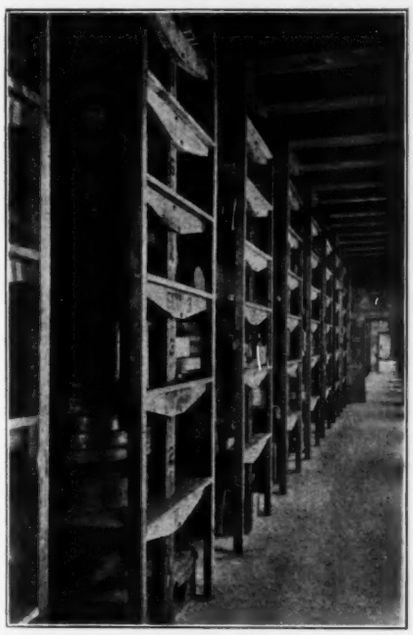


FIG. 4—AN AISLE IN THE PATTERN STORAGE, SHOWING PATTERN RACKS.

the building proceeds, additional cranes will be added.

There are three air furnaces and one 84-inch cupola already installed and the size of castings is only limited by transportation facilities. There is melting capacity to pour 250 tons. The 25-foot bay also contains the brass foundry, which is equipped with both crucible furnaces and converter.

Between the foundry building and the railroad tracks which border the river is a storage and flask yard served by an 85-foot span, single legged gantry of 30 tons capacity, and a second crane for this yard is in process of construction. The fuel for the air furnaces is dumped from hopper cars on the track alongside the foundry building into a concrete pit from which it is taken by conveyors which distribute to all the furnaces.

The entire trackage and switching and yard crane service is very complete and provides for the utmost dispatch with minimum of labor and disturbance in handling material.

FIG. 5—CORE OVEN FURNACE ROOM

MOLDING SAND FOR ALUMINUM CASTINGS.

A ground carbon for mixing with molding sand used in casting aluminum is the subject of a patent recently granted to Earl Blough, associated with the Aluminum Co. of America, New Kensington, Pa. The material is in the nature of a ground carbon consisting of petroleum coke, 50 per cent; electric light carbon, 25 per cent, and coal tar pitch, 25 per cent. These ingredients are mixed and baked at a high temperature and subsequently finely ground. It can, however, be ground as fine as necessary for various classes of work, but for ordinary use, 200 mesh sieve is recommended. It is mixed with molding sand in the proportion of 85 of sand to 15 of carbon. This material acts similar to a chill in the mold and being mixed with the sand it has a tendency to chill the entire casting. It is claimed that the tensile strength of an alloy of copper 8, and aluminum 92, is increased from 15 to 25 per cent when cast in a mold in which this carbon is used.

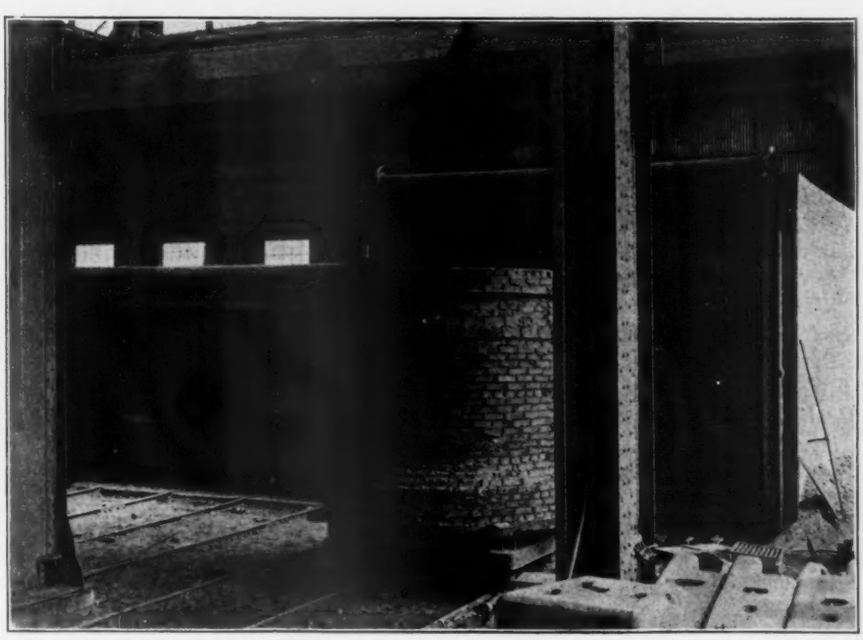


FIG. 6—ONE OF THE LARGE CORE OVENS FOR DRYING LARGE CORES AND MOLDS

THE FOUNDRY

Published monthly by

The Penton Publishing Co.

CLEVELAND

BIRMINGHAM, ENG.....Prince's Chambers.
BUFFALO.....932 Ellicott Sq.
CHICAGO.....1328 Monadnock Block.
CINCINNATI.....First National Bank Bldg.
NEW YORK.....1005 West Street Bldg.
PITTSBURG.....510 Park Bldg.
SEATTLE.....302 Pioneer Bldg.

Copyright, 1909, by Penton Publishing Co., in the United States and Great Britain.

The subscription price of THE FOUNDRY is $1.00 a year in the United States and Mexico. To Canada, $1.50. To Great Britain, Eight Shillings. Single copies, 15 cents each. Back numbers, three months or more, 25 cents each.

Change of advertising copy must reach this office on the 10th of the month preceding date of publication.

The Cleveland News Company will supply the trade with THE FOUNDRY through the regular channels of the American News Co.

European Agents: The International News Company, Breams Building, Chancery Lane, London, E. C., England.

PAID CIRCULATION OF THE FOUNDRY

January	9,143
February	9,305
March	9,516
April	9,702
May	10,023
June	10,106
July	10,139
August	10,171
September	10,211

Entered as second-class matter at the Post-Office at Cleveland, O.

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Trade Outlook

Reports from all sections indicate a distinct revival in all branches of the foundry industry, and while the shops are by no means operating at normal capacity, nevertheless, the melt is increasing from day to day. Railroad requirements are constantly increasing and orders for castings for the large number of cars already contracted for are now being placed with foundries throughout the country. The jobbing shops have, however, not shared in the general improvement up to date, although the melt is considerably heavier than 60 days ago. Steel foundries, particularly in the east, report a large volume of business, while the plants located in the west are operating at only slightly less than normal capacity. A number of large malleable plants have recently fired all of their furnaces, while no shops are reported idle on account of the dearth in tonnage. The automobile industry is productive of some very large orders for aluminum and brass castings, while one concern building a popular price car is using practically all malleable castings in its construction. Among the large contracts for aluminum castings recently placed are orders for 30,000 and 12,000 crank cases respectively, for delivery during the next nine months. In this connection, the organization of the Aluminum Castings Co., a consolidation of six of the largest aluminum foundries in the country, is not without interest. This concern will consume approximately 8,000,000 pounds of aluminum per year, and takes first rank as a user of this metal. Reports from all sections of the country indicate a shortage of common labor. The demand for molding machines continues to show a rapid growth, and recent sales are more numerous than at any time in the past two years. New plant construction in the foundry industry is also notable and is especially marked at this time in view of the lull in new enterprises in the last 18 months. The pig iron market displays increased strength from week to week and many consumers are covering requirements through the first quarter of 1910. While advances have been made in several sections, quotations are being well maintained on a normal basis despite the heavy buying movement in recent months. We quote as follows: Foundry No. 2 standard, Philadelphia, $17.25; foundry No. 2, local, Chicago, $17.00; foundry No. 2, Pittsburg, $16.40; foundry No. 2, Birmingham, $13.50; basic, delivered eastern Pennsylvania, $17.25; basic, Pittsburg, $16.15; gray forge, Pittsburg, $15.15; Lake Superior charcoal, Chicago, $19.50.

THE HOODOO IN PIG IRON.

To the Editor:—

While we are forming societies to look into the mysterious influences that control the spirits of the living and the dead, why not form a society to look into the bad spirits that control pig iron? In an article published in the August FOUNDRY, Herbert Ramp writes as follows: "There are certain furnaces, both in the north and south, that produce iron, the natural composition of which is to be hot short, develops shrinkage holes and spongy spots where two sections of unequal area join." He says further that the composition of these irons may be all right chemically, but they produce bad castings. It would be a great boon to the foundries if Mr. Ramp would publish a list of these furnaces producing evil iron and name each brand. The troubles are said to be physical, not chemical. This takes a burden off chemistry, which used to be called a black art. The writer is not connected with a blast furnace and has no interest in any brand of pig iron, but he has heard the story so often of something wrong in the brand that he would like to see some proof of the assertion. Twenty-five years of experience in melting all kinds of pig iron have not brought to view a single instance where an iron of good composition has been the cause of bad castings, and the writer hopes that this superstition will now be allowed to die a natural death.

N. W. SHED.

PERSONAL.

J. Kent Smith has resigned as chief metallurgist of the American Vanadium Co., Pittsburg, and will return to Europe, where he will probably engage in engineering work in a consulting capacity.

H. E. Longwell, of the Westinghouse Machine Co., East Pittsburg, Pa., has been appointed consulting engineer with particular jurisdiction over the publicity work of the company, and W. A. Bole has been made western manager of the works of the same concern with jurisdiction over the Trafford City works.

J. A. Gearhart has severed his connection with the Pennsylvania Railroad as material inspector, and has associated himself with the Gulick-Henderson Co., Pittsburg, as manager of its inspection department.

Owing to ill health, Chas. J. Caley, general manager of the Russell & Irwin Mfg. Co., New Britain, Conn., has resigned, but will continue to act on the board of directors, and as soon as his health will permit, will assume some advisory position. Mr.

Caley was president of the American Brass Founders' Association for several years.

George H. Wadsworth, superintendent of the Falls Rivet & Machine Co., Cuyahoga Falls, O., inventor of the Wadsworth core making machinery, sailed for England on the Lusitania on Wednesday, Aug. 18. Mr. Wadsworth expects to visit England, Scotland, France and Germany.

Asa W. Whitney, who recently resigned as secretary and metallurgist of the Sanford-Day Iron Works, Knoxville, Tenn., has associated himself with the Enterprise Foundry & Machine Co., Bristol, Tenn.-Va., which has installed equipment for the manufacture of car wheels and mine cars.

J. A. Lanigan, who has been superintendent of the iron, steel and brass foundries of the Whitney Iron Works, New Orleans, has accepted the position of superintendent of the new iron, steel and brass foundry that is being built by the Twin City Rapid Transit Co., St. Paul, Minn.

Walter C. Allen, superintendent of the works of the Yale & Towne Mfg. Co., Stamford, Conn., has been appointed general manager to succeed Kirk Brown, recently resigned. Jos. A. Horne, assistant superintendent, has been appointed general superintendent.

TEMPERATURES FOR ANNEALING STEEL CASTINGS.

By G. B. Waterhouse

The correct temperatures at which to anneal steel castings, to obtain the best results, is of considerable importance, and information along this line is always cordially welcomed. Considerable work has been done by various experimenters on the temperature necessary to remove the coarse structure of overheated steel, and in general it has been thought that a like temperature would give equally good results with steel castings.

Both an untreated casting and an overheated steel give a coarse fracture, but it is due to different effects, and under the microscope the difference in structure is well marked.

In Volume VIII of the *Transactions of the American Society for Testing Materials*, is a short paper bearing directly on this subject and giving definite results of great value. It is published by Prof. Howe, Dr. Campbell and W. T. Koken and is entitled, "Can ingotism be cured by prolonged exposure to the temperature at which overheating is cured?"

The steel casting worked on had the following composition: Carbon, 0.43 per cent; silicon, 0.40 per cent; manganese, 0.78 per cent; phosphorus, 0.05 per cent, and sulphur, 0.05 per cent.

For comparative work, a rolled steel section was taken containing carbon, 0.83 per cent; phosphorus, 0.06 per cent, and sulphur, 0.04 per cent.

The casting was tested both in the untreated condition, when it presented the coarse "ingotism," and after having had this coarse structure removed by heating to 1,377 degrees Cent. The rolled steel was examined and tested after being given a coarse structure by heating to the same temperature, 1,377 degrees Cent.

A series of sets were made, each consisting of one piece of the untreated casting, one piece of the treated casting and one piece of the treated rolled steel. Each set was then heated to a definite high temperature, and cooled slowly, then sections prepared and carefully examined microscopically. The results are given in Table I.

Table I.

No.	Temperature attained. Degrees, Cent.	Effect on coarse structure. Untreated casting.	Treated casting.	Treated rolled steel.
1	804	Not effaced.	Not effaced.	Not effaced.
2	840	Not effaced.	Effaced.	Effaced.
3	861	Not effaced.	Effaced and new network begins.	Effaced and new network begins.
4	1000	Not effaced.	Effaced and new network begins.	Effaced and new network begins.
5	1059	Not effaced.		
6	1118	Not effaced.		
7	1171	Not effaced.		
8	1180	Not effaced.		
9	1194	Effaced.		

Then the untreated steel casting was heated to 840 degrees Cent., held there for various lengths of time, cooled slowly and again examined. The results are shown in Table II.

Table II.

No.	Hours held at 840 degrees Cent.	Effect on coarse "Ingotism" Structure.
10	2	Not effaced.
11	8	Not effaced.
12	16	Not effaced.
13	24	Not effaced.
14	32	Not effaced.

The results show first, that the coarse ferrite network formed in the casting by overheating is removed between 804 and 840 degrees Cent., which is probably a little above the upper change point; second, "ingotism," or the coarse structure of the untreated casting, is not effaced, even by an exposure of 32 hours to this temperature; third, the temperature at which "ingotism" is cured rapidly, in this steel, is between 1,180 degrees and 1,194 degrees Cent.; fourth, the temperature at which the overheated structure is refined is substantially that for overheated rolled steel of a like composition.

They bring out, in an unmistakable manner, that a much higher temperature is needed to remove "ingotism" than that necessary to refine the ordinary coarse structure of an overheated steel.

MELTING NICKEL ALLOYS.

The method of melting nickel alloys in c ay-lined crucibles is described in a patent recently issued to John T. H. Dempster of the General Electric Co., Schenectady, N. Y. The following nickel alloy is used by the inventor: Nickel, 62 per cent; iron, 20 per cent; chromium, 13 per cent, and manganese, 5 per cent.

This alloy is used by the General Electric Co., for resistance wire, and to roll it into sheets, or draw it into wire, it must be absolutely free from carbon. If an ordinary graphite crucible is used, the metals take up so much carbon that they cannot be drawn into wire, and as commercial nickel contains a small amount of carbon, it is necessary to remove it, and this is done in the crucible by the following method:

The clay-lined crucible used is the regular graphite type lined with a fire-clay mixture. In the bottom of the crucible some red oxide of iron is placed. This oxide is the mineral known as "hematite" or any pure artificial material may be employed. For 100 pounds of the alloy melted, 8 pounds of this oxide of iron is used.

The nickel is then charged into the crucible on top of the oxide of iron, and a small quantity of silica and cryolite is added for a flux. When the nickel is melted, the heat is increased to promote a vigorous action between the oxide of iron and the carbon in the nickel. The action is shown by the gas bubbles which escape from the molten metal and burn with a blue flame. After the nickel has quieted down and the gas has all escaped, the carbon is eliminated and the iron and chromium are introduced. When this has been done and the mass is thoroughly melted, the manganese is added. The mixture must then be poured as soon as the manganese has melted in order to prevent the attacking of the clay lining.

By melting the alloy in this manner, it is possible, the inventor says, to eliminate the carbon from the nickel and produce a ductile alloy that will draw into wire.

FOUNDRY AND PATTERN SHOP EQUIPMENT

Portable electric pyrometer --- Large hydraulic molding machine --- Sand mixer and sifting machine --- Core wire straightening machine --- Malleable annealing furnace

THE Wm. H. Bristol electric pyrometers have been made in both switchboard and portable form to indicate or record high temperatures, but most of the instruments now in service are for ranges of temperature lower than 2,000 degrees Fahr. There are quite a number of processes in which excessively high temperatures are used and these temperatures should be measured intermittently in order to make control possible and to obtain a uniform product. In experimental work, temperatures in the neighborhood of 2,500 Fahr. should often be measured, as for instance in boiler tests where the boiler furnace temperature is to be determined.

FIG. 1—BRISTOL PORTABLE ELECTRIC PYROMETER FOR QUICK READINGS OF HIGH TEMPERATURES

A new, quick-reading form of the Wm. H. Bristol pyrometers has been designed, and preliminary models tested in actual service in several different processes where the temperatures are excessively high and the requirements very severe. This special pyrometer consists of a compound thermo-electric couple used in connection with a special, portable instrument. The complete outfit is shown in Fig. 1. The thermo-electric couple is shown externally in Fig. 2.

Fig. 1 shows the couple with the protecting sheath pulled back against a stop, leaving the tip of the thermo-couple exposed. When a reading is to be taken with this special thermo-couple, it is inserted into the furnace or kiln as shown in Fig. 2, with the tip protected from mechanical injury, and as soon as the couple has been inserted at the proper point in the kiln, the iron pipe protecting sheath is slipped back so that the tip is exposed to the hot gases whose temperature is to be measured. After a reading has been taken, the couple should be quickly withdrawn and partially cooled off before another reading is taken.

FIG. 2—THERMO-ELECTRIC COUPLE COVERED WITH PROTECTING SHEATH

The compound construction of this couple is shown in Fig. 3. The point A corresponds to the regular junction of an ordinary thermo-couple and the two elements which join at the point A are platinum and platinum-rhodium, this being the particular couple selected as a standard by the German government. The platinum platinum-rhodium elements extend to the points B and C, where they are welded to two other wires, made of inexpensive alloys, which are such that the electro-motive forces generated at B and C are practically equal and opposed when these junctions are both exposed to temperatures not higher than 1,200 degrees Fahr. These inexpensive alloy elements are extended to the point D, which is the cold end of the couple.

This construction of the quick-reading couple is such that the platinum-rhodium tip of the couple A may be exposed to excessively high temperatures up to 3,000 degrees Fahr., without having the temperature of the junctions B and C exceed a safe limit. The temperature at A may be quickly measured with this special couple, as the platinum-rhodium tip is exposed directly to the hot gases in the furnace or kiln. In this way an inexpensive substitute is provided for the expensive platinum-rhodium couples.

This quick-reading form of electric

pyrometers has been tested under very severe conditions and found extremely valuable for such applications as brick kiln temperatures, boiler furnace fire box temperatures, by-product coke oven combustion flue temperatures, soaking pit temperatures, etc. The complete outfit is portable, and readings of temperatures in the neighborhood of 2,500 degrees Fahr., may be obtained in a very few seconds after inserting the tip of the couple to the point where the temperature is to be measured. By using a special form of the platinum platinum-rhodium tip, this type of thermo-couple can be used to measure the temperature of red hot surfaces of metal or other material. This quick-reading pyrometer is manufactured by the Bristol Co., Waterbury, Conn.

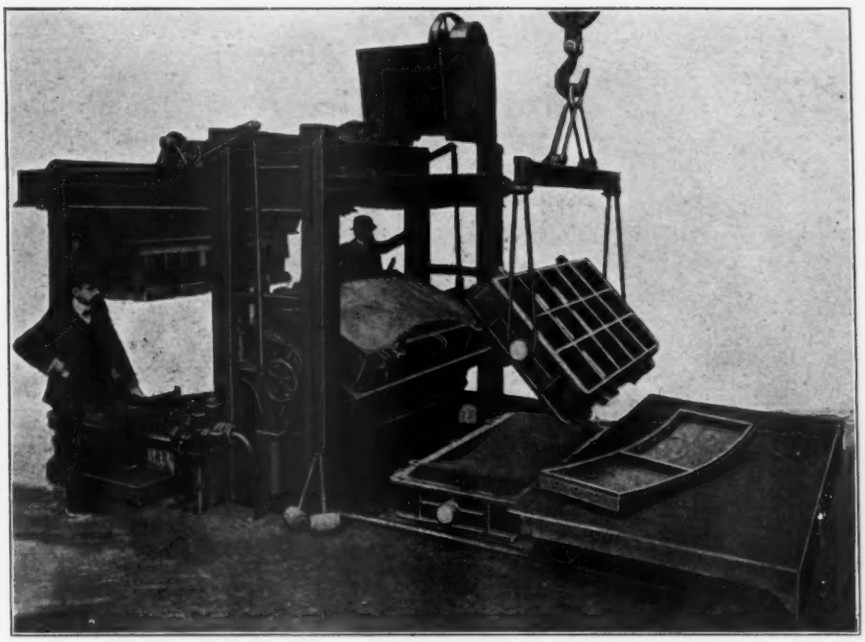


FIG. 1—HYDRAULIC MOLDING MACHINE USED FOR MOLDING TUNNEL PLATES

A LARGE HYDRAULIC MOLDING MACHINE.

A large hydraulic molding machine for molding tunnel plates, boiler sections, etc., is shown in Fig. 1. Hydraulic power is used to ram the molds and draw the patterns, while the flasks are handled by a traveling crane. The reason of many failures that have been experienced in foundries from the adoption of hydraulic machinery for pressing molds can be attributed to the neglect of many essential features. The machine should be especially adapted for the work, and special attention should be given to the preparation of the molding sand. The patterns, and the mounting of the same on the pattern plates, are always factors of importance which should be given careful consideration.

In Fig. 1 the large turn-over hydraulic molding machine is shown fitted with a pattern plate for molding tunnel plates. One of the castings is shown on the industrial car in the foreground, while the cope flask is suspended from a crane. After the mold has been pressed, the machine is rolled over to permit of the removal of the flask. Fig. 2 gives a better view of the turn-over plate. It is fitted with a white metal pattern and a pneumatic vibrator is shown attached to the turn-over plate. In the foreground is illustrated a boiler section that has been cast in a mold made on the machine. The size of the flask for this casting is 5 feet x 3 feet 8 inches. Four men have produced 16 tunnel plates on the machine shown in Fig. 1 and 28 boiler sections on the machine shown in Fig. 2, in one day. This included the casting of the molds and the shaking out of the flasks. The flasks for the tunnel plates are 6 feet 6

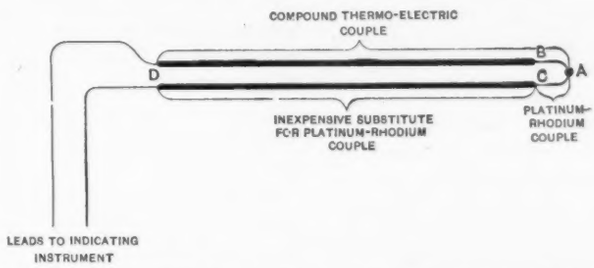


FIG. 3—CONSTRUCTION OF BRISTOL THERMO-ELECTRIC COUPLE

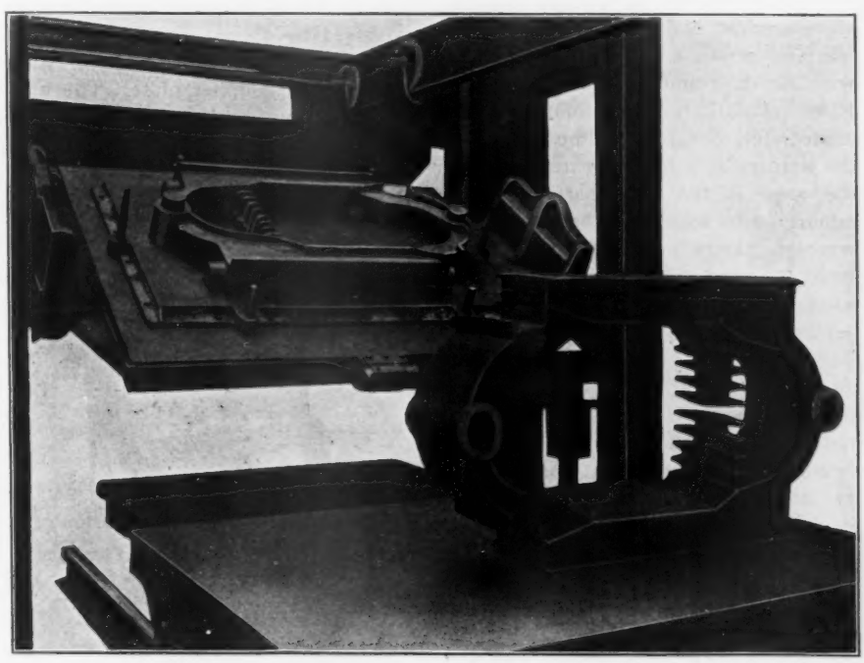
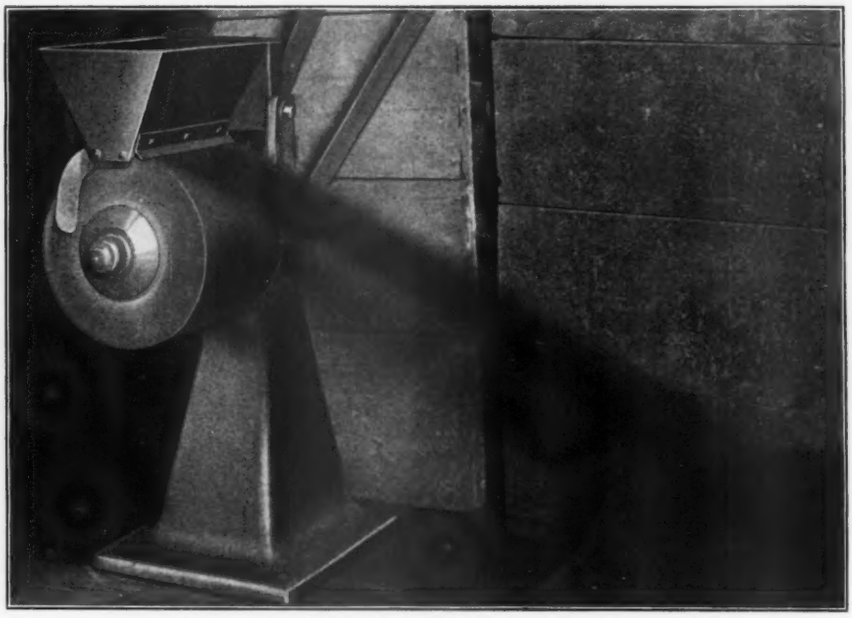


FIG. 2—LARGE BOILER SECTION PATTERN MOUNTED ON A HYDRAULIC MOLDING MACHINE. THE CASTING IS ON THE TABLE IN THE FOREGROUND



BILZ SAND MIXER AND SIFTING MACHINE

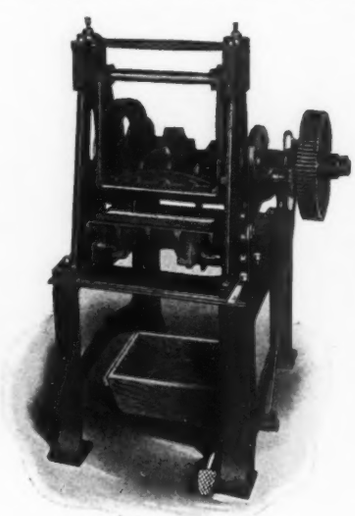
inches x 3 feet 3 inches. This machine is built by the London Emery Works Co., London, England.

BILZ SAND MIXER AND SIFTING MACHINE.

The accompanying illustration clearly shows the construction and method of operation of a combined sand mixer and sifting machine which has been placed before the foundry trade by Walls, Bray & Co., 83 Walker street, New York City, and which in a short time has been installed in a number of leading plants where the old-time sieve method had been employed. The machine consists merely of a circular wire brush, running at from 1,000 to 1,100 revolutions per minute, located immediately below and almost touching the bottom of a hopper through which the sand is fed for treatment. The rapidity with which the brush revolves serves to throw out all foreign matter, such as wood, nails, stones, etc., depositing this refuse in a heap, well beyond that into which the sand is thrown. The sand, in traveling through the air, is thoroughly mixed and is deposited in better shape for casting work than can be secured through hand treatment. Aside from its large capacity, normally from 50 to 75 barrels per day, the device eliminates the necessity of drying the wet French sand before putting it through the sieve, avoids the danger arising from broken wires under the old process and has other apparent advantages. The brush is belt driven and is practically self-lubricating.

CORE WIRE STRAIGHTENING MACHINE.

The core wire straightening machine shown in the accompanying illustration, manufactured by the Gregg Mfg. Co., Cleveland, is designed for straightening core wires of various diameters, and any lengths up to 18 inches. The machine is built on novel lines, having for its fundamental principle the well-known method of rolling a pin on the floor under the foot to straighten the same. The machine is provided with an upper and lower plate, each having a sliding lip, which takes its height from the diameter of the wire placed in the machine. The lower plate is raised by a cam on the back crank shaft, which raises the plate to within ¼-inch of the upper plate. The upper plate is then swung forward by the back crank shaft and when the two sliding lips, previously referred to, come together on the wire, the lower plate is raised so that a heavy pressure is placed on the wire and at the same time the upper lip is drawn back, rolling the wire between the two plates. The machine is provided with automatic spring adjustments which make it unnecessary to adjust the same regardless of the size of the work. The wire, after being straightened, is dropped into a box underneath the machine ready for use. It has a capacity of from 35 to 40 pounds of wire per hour, depending upon the size. The machine is of the gear type and is operated by a treadle.



CORE WIRE STRAIGHTENING MACHINE

GROUND FERRO-SILICON AND FERRO-MANGANESE.

Robert Gilchrist & Co., recently incorporated under New Jersey laws, will grind ferro-silicon and ferro-manganese for foundry and steel works' requirements, and have established offices at 50 Church street, New York City. This concern has purchased from the receivers of the Western Foundry Supply Co., the mill formerly operated by that interest at Elizabethport, N. J., which will be enlarged and equipped with new grinding machinery. Ground manganese dioxide will also be manufactured. Robert Gilchrist, president of this concern, is well known to the foundry trade through his long association with the New York office of Rogers, Brown & Co.

TRADE NOTES.

The New Era Mfg. Co., Kalamazoo, Mich., reports a heavy demand for its phosphoro, anti-friction bronze, especially intended for use in journal bearings. The following formulas are recommended for making anti-friction bronze mixtures: No. 1, copper, 80 pounds, tin 10 pounds, lead 8 pounds, metallic phosphoro 2 pounds; No. 2, copper 80 pounds, tin 10½ pounds, lead 8 pounds, metallic phosphoro 1½ pounds; No. 3, copper 80 pounds, tin 11 pounds, lead 8 pounds, metallic phosphoro 1 pound.

The Gobeille Pattern Co., Niagara Falls, N. Y., has issued a nevel booklet which contains extracts from numerous unsolicited letters received by Joseph Leon Gobeille at the time of the formation of this new patternmaking concern.

The Hamilton Engineering Co., Hamilton, O., has been organized to engage in the manufacture of jolt ramming molding machines, sand mixing and tempering machines, the Murphy water blast for cleaning castings, under-fired core ovens, Murphy sec-

tional curbing and other foundry equipment. James A. Murphy, foundry superintendent of the Hooven-Owens-Rentschler Co., Hamilton, O., is president, and Philip J. Conroy, secretary and general manager. Headquarters have been established at 108 North Monument street.

The W. W. Tice Mfg. Co., Piqua, O., is manufacturing a material known by the trade name of "Ticeoleum," which is adapted for dressing brass, iron and other metal patterns. It is applied to the patterns and prevents them from adhering to the sand when they are returned for printing. This material also prevents the patterns from rusting and the patterns draw from the sand much better than when the bare metal comes in contact with it. "Ticeoleum" is sold in liquid form.

MALLEABLE ANNEALING FURNACE.

A furnace for annealing malleable castings without the use of cast iron pots, and in which the castings are charged direct with the usual covering

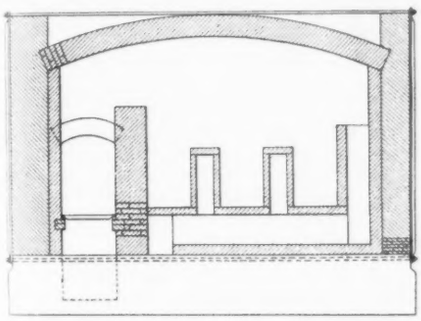


FIG. 1—CROSS SECTION OF MALLEABLE ANNEALING FURNACE

of scale, is shown in the accompanying illustrations. The elimination of the pots reduces the annealing costs materially and also effects a saving in the labor involved in handling these bulky boxes. In addition, the furnace is constructed so as to insure a uniform annealing temperature throughout, thereby preventing the over or under annealing of the castings.

A cross section of the furnace is shown in Fig. 1, a perspective view illustrating the method of charging the castings is shown in Fig. 2, and Fig. 3 is a longitudinal section. The fire pot extends the length of the furnace, which is provided with the customary arched roof. The side wall opposite the fire box is thicker than the one directly adjoining the same to accommodate a series of flues, the upper ends of which communicate with the oven at a point slightly above the level of the bridge wall, and the lower ends communicate with corresponding transverse flues extending beneath the floor of the oven. This series of communicating flues occupies the full internal length of the oven and constitutes a continuous flue space surrounding its two sides. Below the oven bottom and at the side adjacent to the bridge wall there is provided a longitudinal flue which communicates with the stack. Each of the transverse flues discharges into this flue, and the products of combustion from the fire box pass up over the bridge wall, across the charge in the furnace, and pass down through the flues in the side wall opposite the fire box, into the transverse flues, and thence into the longitudinal flue leading to the stack. The purpose of providing a plurality of flues rather than a single continuous flue in the side wall is to strengthen the construction of the inner side wall of these flues and of the bottom of the oven, by means of partitions between the individual flues.

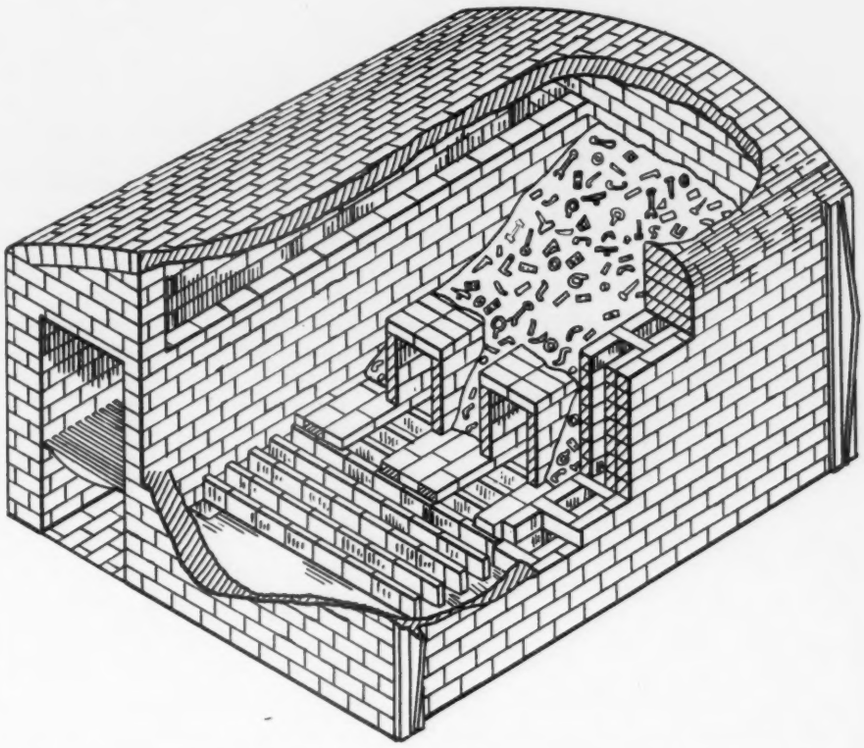


FIG. 2—PERSPECTIVE VIEW OF MALLEABLE ANNEALING FURNACE, SHOWING METHOD OF CHARGING CASTINGS.

In Fig. 2 are shown a number of chambers or pockets which extend longitudinally of the furnace from front to rear. These chambers are built of fire brick and are enclosed on all sides except the bottom, which is open and which communicates with the stack.

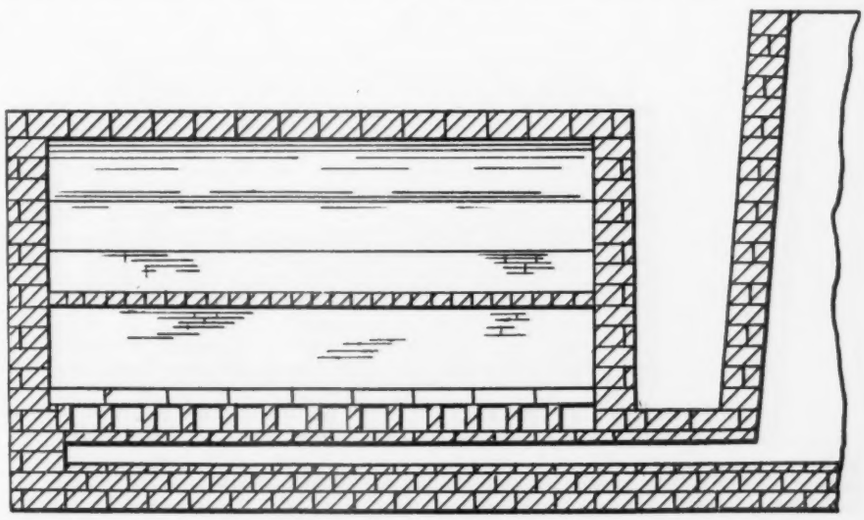


FIG. 3—LONGITUDINAL SECTION OF MALLEABLE ANNEALING FURNACE

These pockets extend upwardly to within a short distance of the top of the fire or bridge wall. The number and dimensions of these pockets depend upon the size of the oven in which they are used. The castings and scale are packed in between and on top of the pockets and between the same and the adjacent bridge and flue walls. These pockets are constantly filled with the hottest products of combustion, and the fact that they communicate freely with the entire flue space beneath the floor, insures an even distribution of the heat. To make the furnace absolutely air tight a curtain wall is built up inside the furnace door, one course of brick being used laid in mud. Owing to its flue construction, a smaller amount of fuel is required to anneal castings, and together with the saving effected in the use of cast iron pots, it is claimed that the annealing cost in furnaces of this type is reduced 50 per cent. At one plant where a battery of these furnaces has been installed, on an output of 2½ tons daily, the annealing cost has been reduced $14,000 per year. This furnace has been designed and is patented by August Bergman, Bellevue, O.

CONSOLIDATION OF ALUMINUM FOUNDRIES.

The Aluminum Castings Co., Cleveland, recently organized with a capital stock of $800,000, has acquired six large aluminum casting foundries which also operate brass departments of considerable size. The plants absorbed include the Allyne Foundry Co.'s plants at Cleveland, Detroit and Buffalo, the Syracuse Aluminum & Bronze Co., Syracuse, N. Y., the Eclipse Foundry Co., Detroit, and the foundry department of the United States Aluminum Co., New Kensington, Pa. The brass departments of the original Allyne plants will be operated under the firm name of The Allyne Brass Foundry Co. This concern will be the largest individual consumer of aluminum in the world, the annual requirements being estimated at from 7,000,000 to 8,000,000 pounds. The foundries absorbed will be operated under the existing managements.

The capacity of the Cleveland plant will practically be doubled when extensions now under way are completed. These include a new foundry, 61 x 256 feet, core room 60 x 99 feet, pattern shop and a new office building, 90 x 58 feet, two stories high. Plans have been prepared by the Moore Engineering Co., Cleveland, for a new brass and aluminum casting plant, to be built in Detroit, where a site of 24 acres has been purchased on Chene street. The general arrangement of this foundry will be unique in that it will be constructed and operated on the unit system throughout. It will consist of five buildings of the same size, each being a complete foundry in itself, provided with core, molding, casting and grinding departments. The most improved sand handling and conveying equipment will be installed, the sand being dropped directly from cars to storage bins from which it will be carried by conveyors to the core benches from a mixer. The metal from the melting furnaces will be conveyed in crucibles by overhead trolleys to the molding floors. The cleaning and grinding rooms will be provided with an exhaust system and the chipping blocks will be made of concrete in the form of cylinders filled with sand to deaden, as much as possible, the noise of the pneumatic chippers. All of the grinders will be electrically operated. Flaming arc lamps will be installed, inasmuch as this light penetrates the vapors and gives a well diffused light throughout the shop. An experimental laboratory will also be provided. The welfare of the employes has been provided for in every detail of design and the walls of the buildings will be almost entirely of glass.

GENERAL INDUSTRIAL NOTES

The Central of Georgia railroad is building new shops at Macon, Ga., which, among other departments, will include a brass foundry, 30 x 40 feet.

The A. P. Smith Mfg. Co., Newark, N. J., will erect a new plant in Bloomfield, N. J., for the manufacture of tapping machinery, valve fittings and general supplies for water works. The plant will include an iron foundry, 100 x 140 feet, brass foundry, 50 x 120 feet, and a pattern storage building, three stories high, 45 x 90 feet.

The Portland Foundry & Machine Co., Portland, Ind., is preparing to erect a modern drop forging plant, foundry and machine shop upon a site of four acres recently acquired.

The Pequonnock Foundry, Inc., Bridgeport, Conn., manufacturer of gray iron castings, will erect a new plant on a tract of land acquired in the eastern section of that city. The main foundry will be of steel construction, 75 x 140 feet.

The North & Judd Mfg. Co., Bridgeport, Conn., manufacturer of saddlery hardware, is adding a one-story brick building to its plant, 60 x 150 feet.

The Milwaukee Aluminum Mfg. Co., Milwaukee, will erect a new foundry, 34 x 140 feet.

The Buhl Malleable Co., Detroit, has taken over the contracts of the Western Malleable Steel Co, of that city, for malleable steel castings, and has made arrangements to fill these orders as well as the current tonnage for these castings at that plant for 60 days. At the expiration of this period, a new foundry adjoining the Buhl Malleable Co.'s plant will be completed, consisting of two buildings 90 x 115 feet, and 62 x 180 feet, respectively. J. P. McManus, who has had a wide experience in steel works in Sharon, Pa., and has recently been associated with the Malleable Steel Castings Co., will have charge of the malleable steel casting department of the Buhl company.

Work is now in progress on the addition to the Cook-Lewis Foundry Co.'s plant at Salem, N. C.

The Brazil Machine & Foundry Co., Brazil, Ind., successor to the Adrian Brick & Tile Machine Co., expects to begin the erection of a new foundry, 50 x 100 feet, in the near future. The equipment of this plant will be moved from the old shop at Adrian.

T. F. McGann & Sons, brass founders, 104 Portland street, Boston, Mass., will build a new brass foundry in Somerville, Mass.

B. F. Avery & Sons, Louisville, Ky., will erect a new plant consisting of 11 buildings, which will include a foundry, 95 x 224 feet, core shop, 31 x 85 feet, and a pattern shop, 64 x 96 feet.

The American Laundry Machinery Co., Rochester, N. Y., will soon erect a new foundry and machine shop for the manufacture of laundry machinery. The new plant will involve an expenditure of about $200,000.

The McDowell Foundry Co., Chicago Heights, Ill., has been incorporated with $50,000 capital by Irvin and Hanson McDowell. A foundry, 125 x 150 x 75 feet, will be built. This concern will do a jobbing business in gray iron and semi-steel castings, and the plant will have an output of about 20 tons daily. This concern is in the market for all classes of foundry equipment.

The National Malleable Castings Co., Cleveland, is erecting an addition to its plant, 276 x 100 feet.

The Ketcham Iron Co., Ft. Smith, Ark., is erecting a foundry, 160 x 60 feet.

The Billings Foundry Co., Billings, Mont., has begun the construction of a plant which will be ready for operation in about 30 days.

The Valk Mfg. Co., Topeka, Kans., expects to build a foundry in the fall and would like to receive catalogs of foundry supplies and equipment.

The Youngstown Foundry & Machine Co., Youngstown, O., will add one 25-ton and one 15-ton air furnace, as well as a cupola, to its melting equipment. This concern has decided to manufacture sheet and tin mill rolls on a larger scale than heretofore. A number of roll lathes and other machinery will also be installed.

The Niles & Scott Co., La Porte, Ind., will erect an addition to its foundry, 60 x 75 feet.

The Adrian Steel Casting Co., Adrian, Mich., is erecting an addition to its foundry, 100 x 50 feet.

A. G. Eberly, J. Howard Schwartz, James P. Shaw, A. S. Jacobson and others, of Mechanicsburg, Pa., who recently purchased the plant of the Yost Vise Co., that has been remodeled for foundry purposes, will shortly begin operations.